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NATURAL RESOURCES AND ENVIRONMENTAL CONCERNS IN SUB-SAHARAN AFRICA

A Review
With Preliminary Recommendations
For A Plan To Support The
Management of Natural Resources
In Sub-Saharan Africa

August 12, 1986

Bureau for Africa
Agency for International Development
Washington, D.C. 20523

Executive Summary

1.0 Introduction

A plan for supporting natural resources management in Sub-Saharan Africa is being prepared under the guidance of an intra-agency working group, comprised of staff from the Africa Bureau and the Bureau for Science and Technology.

The goal of the plan is to provide a framework for a more coherent and effective long-term AID response to needs in natural resources and environmental management

The planning process was designed so as to:

* create a programmatic framework for setting priorities, by management needs or by sub-regions

* develop a common understanding of the various resource management and environmental problems affecting Sub-Saharan Africa.

* analyze various solutions, needs, and opportunities to resolving managment problems

* recommend courses of action.

This document constitutes a background review and analysis of renewable natural resources and environmental management problems in Sub-Saharan Africa. It provides the analytical building blocks to be used in the formulation of a programmatic framework and plan. That plan will be prepared as a separate document in September.

The material in this document will be reviewed within AID and also by outside experts in August for accuracy, validation of the orientation and suggestions. Next a plan will be drafted by AID staff that takes into account these reviews as well as the technical analyses contained herein.

The plan will reflect the need to more effectively integrate agricultural and energy development and natural resources management. It should also provide the basis for cooperative efforts with other development assistance organizations, public and non-governmental.

2.0 Natural resource and environmental problems

Seven problems were identified at the outset of the planning:

* soil erosion
* soil productivity -- loss
* vegetation -- loss or degradation
* water resources -- degradation by pollution, salinization, etc.
* biological resources -- loss, decline of diversity
* coastal resources -- loss, degradation
* stresses on natural resources due to drought

These problems were reviewed indivdually, in terms of state of existing knowledge, known responses or solutions, and experiences with development assistance.

Next sub-Saharan Africa was divided into a number of sub-regions, using agro-ecological criteria as well as differences due to population densities and species endemism.

The sub-regions constitute a geographic screen for better understanding natural resource problems and needs in relation to development. It was thought that they could serve to define actions at a programmatic level, embracing several countries, similar to the sub-regional definition used in the Plan for Supporting Agricultural Research and Faculties in Africa.

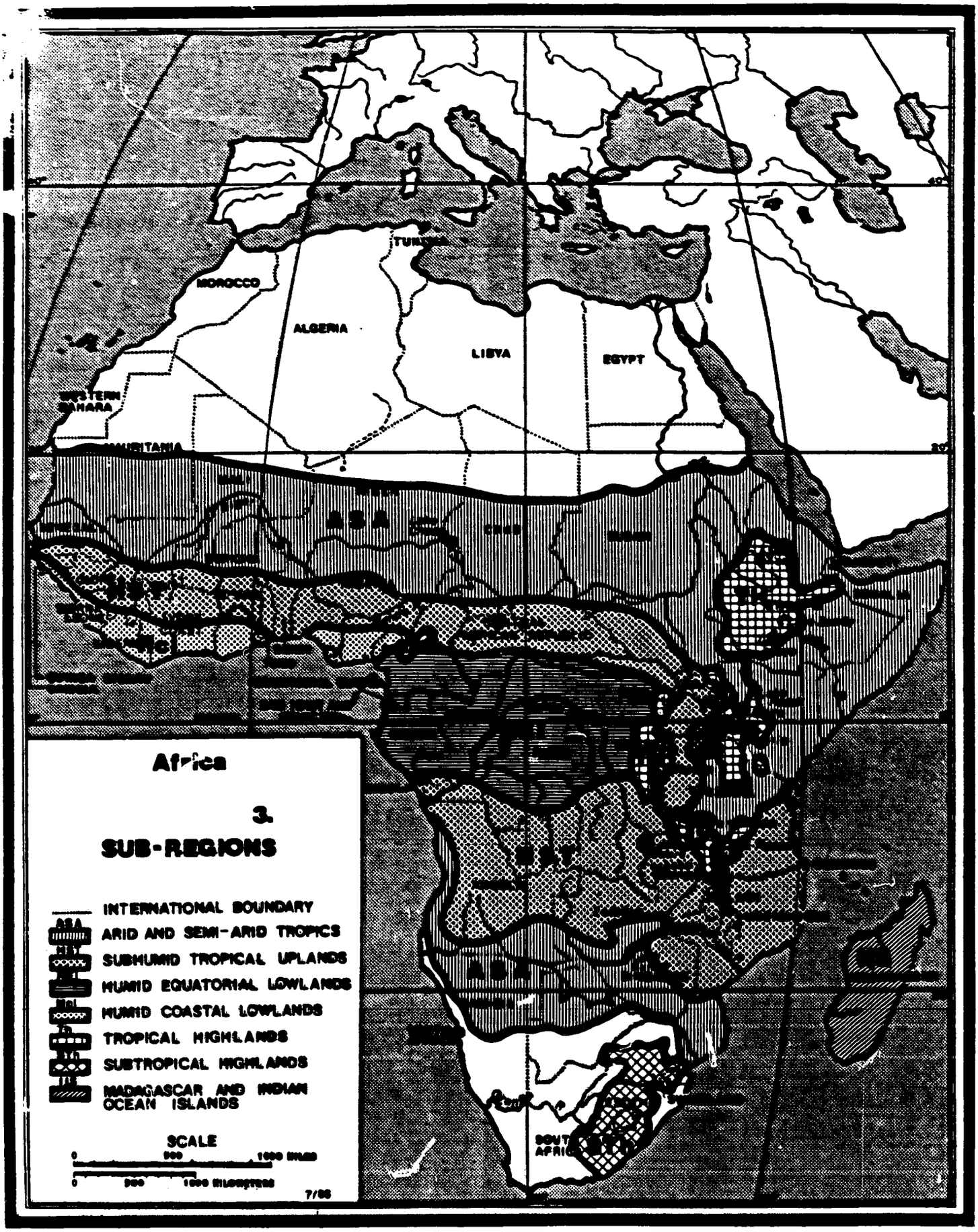
The sub-regions are:

* Arid and semi-arid tropics

  growing period 0-180 days, no cultivation below 350 mm, or approximately 75-day season.

* Sub-humid tropical uplands.

  180 to 270-day growing period., elevations 100-300 meters north of equator and up to 1000 south of equator. One rainy period, except in Ethiopia and Somalia which have two.


Africa
3.
SUB-REGIONS
INTERNATIONAL BOUNDARY
ARID AND SEMI-ARID TROPICS
SUBHUMID TROPICAL UPLANDS
HUMID EQUATORIAL LOWLANDS
HUMID COASTAL LOWLANDS
TROPICAL HIGHLANDS
SUBTROPICAL HIGHLANDS
MADAGASCAR AND INDIAN OCEAN ISLANDS
SCALE
0
500
1000 MILES
0
500
1000 KILOMETRES
7/66
MOROCCO
ALGERIA
LIBYA
EGYPT
WESTERN SAHARA
MAURITANIA

* Humid equatorial lowlands

  270 to 365 day growing period, light population.

* Humid coastal lowlands

  270 to 365 day growing period, dense population.

* African Highlands

  growing period variable, elevations generally above 1,500 meters, dense populations.

* Madagascar and Indian Ocean Islands

  distinguished by floristic endemism and insularity.

Sub-regional areas

(millions of ha)

Arid tropics	553
Semi-arid tropics	386
total	939
Humid equatorial lowlands and Humid coastal lowlands	424
Sub-humid Tropical uplands	278
Highlands of East Africa and Cameroon	97
Madagascar	58
Total	1,796 mill ha

Source: FAO, Report on the Agro-ecological Zones Project, Vol. I, Methodology and Results for Africa. Rome, FAO. 1978

3.0 Resource management problems by sub-region

Arid and Semi-arid Tropics

This is the largest sub-region, and the one with the most serious resource management problems. These include various stages of degradation of agricultural and forested lands in the semi-arid portions and of grazing lands in the arid portion.

Degradation has been exacerbated by the drought, which slowed or stopped tree growth and killed more susceptible trees. Unrelieved exploitation pressures on groundwater and on all vegetation near villages or water holes for fuel or fodder has created deserts in their environs. This environmental degradation has rendered the sub-region and its inhabitants more vulnerable to the drought as well as to the expected years of poor rainfall.

The processes of degradation and of desertification in this sub-region are one and the same. Notwithstanding the considerable amount of popular and scientific writing about desertification in Africa, the actual process has not been monitored or researched. Consequently the rate and reversibility of desertification is poorly known.

Soils are relatively infertile, typically lacking phosphorus and losing organic matter due to over-cultivation.
The arid range can be productive, but has been seriously over-grazed, especially in Botswana, Somalia and parts of the Sahel, particularly where wells and water points have been developed. Tree growth is slow, unless there is abundant shallow groundwater. Growth rates are from less than 1/2 cubic meter to 15 cubic meters per ha per year. Eucalpytus have not grown well at less than 800 mm of rainfall.

Plant genetic resources important to the sub-region's future hve not been thoroughly studied, collected or used in applied research. Wild and domesticated millets and sorghums, browse species, and various legumimous trees species can be cited.

The sub-region's wildlife is important as a tourisim attraction and more generally as a food source. Unique, endangered species are found in Niger and Botswana. The inner deltas of the Sahelian states serve as over-wintering habitats for European waterfowl. Africa's most imprtant wildlife parks are found in this sub-region, but management is weak, and development threatens their viability.

There are critical fuelwood and construction wood shortages throughout the region, especially in the Sahelian states. Rates of exploitation exceed natural growth rates. Fuelwood scarcity is presently a greater limitation than food production to the the population supporting capacity of the semi-arid portion of the sub-region.

Neither small nor large plantings of trees for fuelwood are keeping pace with the consumption, nor do rural people use woodlots for fuel. Polewood is in greater demand. Village nurseries and woodlots are helpful but land for plantations is insufficient where the needs are greatest. Better management of natural forests the wide use of more efficient cooking stoves, and more efficient charcoal making are seen as more effective ways to resolve the fuelwood problem. Urban fuelwood or charcoal shortages pose more complex problems, involving policies concerning cutting fees, concession terms and consumer price controls.

Excessive pruning and removal of trees and bushy vegetation in and around farm fields and villages has interrupted the nutrient cycle, leading to loss of soil fertility, and has increased the exposure of the soil to high temperatures and erosion by wind during the long dry season. Yields are down, but fertility decline has been masked by poor rains or drought.

The restoration of permanent vegetation through the planting of multiple purpose species,such as the Acacia albida, windbreaks and hedges is a pre-requisite for sustainable agriculture in the semi-arid portion of the sub-region. They are essential to the organic matter cycle, and organic matter is essential to soil productivity, even when chemical fertilizers are used.

Numerous experiences with large and small scale projects in the semi-arid zone have demonstrated the feasibility of stabilizing dunes, regeneration of natural vegetation, agroforestry plantings, plantings of construction(pole) wood species, and arresting soil and water loss through erosion control works. Learning how to motivate and actively engage village societies in this work has been critical to project success.

The arid zone range is productive when it grows and resilient to the erratic rainfall regime, especially if grazing and browsing pressures are removed. Perennial browse species that tap deeper groundwater are important sources of dry season forage in the Sahelian range, and they are being over-browsed.

Range and livestock projects have failed to achieve range management, with few exceptions(e.g. IPAL project in Kenya, ODA project in Botswana). Ignorance, misunderstanding of or disregard for the behaviour of traditional pastoral groups appear to have handicapped these projects. Also lacking is a more precise understanding of range ecology.in Africa's arid zones.

The water and the fisheries of rivers and lakes have been used and managed by various groups in this sub-region for centuries. Ground water resources are not well known but are being actively tapped, both at the groundwater table and in deep aquifers.

Some states in the region have large surfaces of irrigable soils: Chad - over 1 million ha; Burkina Faso - 300,000 ha; Kenya - 300,000 ha; and Sudan with the largest surface - 1.6 million ha. Large schemes may be needed in the future for food production, but at present improving existing, small scale, traditional irrigation is being viewed by AID and FAO as the better option.

Modern irrigation has been difficult to develop. The terrain is generally too flat for gravity flow; river flows are markedly seasonal; and good dam and reservoir sites are few. Traditional management of flood plain soils and pasture resources is conflictive with modern schemes. Schistosomiasis has been an inevitable accompaniment of canal-fed irrigation. Large parastatal river basin development organizations have been ineffective and inefficient. Large schemes are devoted to cash crops not food crops.

Nearshore and estuarine fisheries resources in the sub-region's coastal states yield foreign exchange as well as a fish for local consumption. Reported fish catches have increased rapidly in the last decade, but estuarine fisheries are being stressed by a reduction in freshwater inflow due to the drought. Management of marine fisheries exploited by international fleets has been weak. Mangroves are generally not managed and are subject to over-cutting.

Sub-humid Tropical uplands

This sub-region describes a crescent which separates the humid tropics from the arid and semi-arid tropics. Its long growing season of 180-270 days is optimum for all rainfed crops except sweet potatoes. Its uplands are rather remote. The upper headwaters of many important rivers arise in the sub-region: Senegal, Niger, Gambia, and Chari. The sub-region spans many frontiers, and only two states are entirely encompassed: CAR and Malawi.

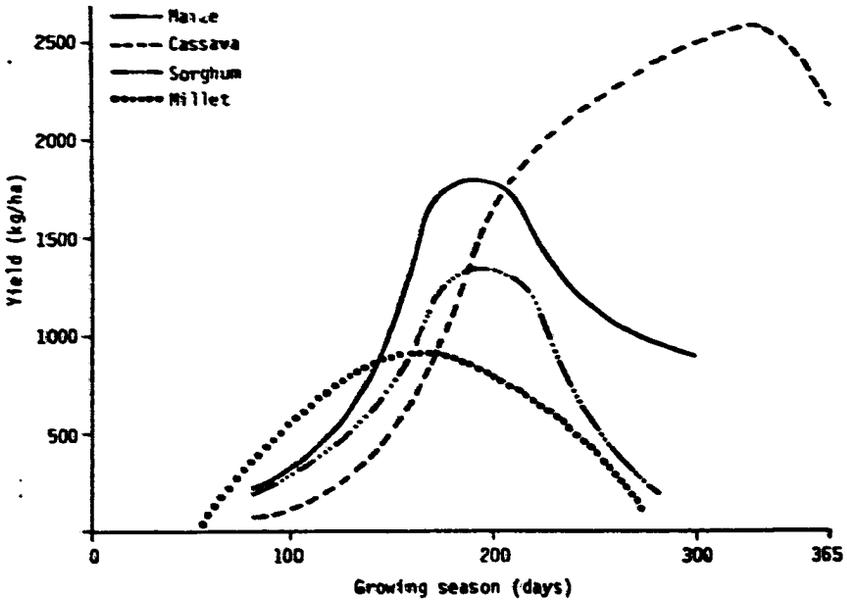


Figure 2. Fluctuations of average yields of millet, maize, sorghum, and cassava in relation to available lengths of growing season.

South of the Congo Basin elevations in this sub-region may attain up to 1000 meter, but north of the Congo Basin elevations are much less -- 100 to 300 meters at most.

Soils are highly variable and in general are very old. Laterite outcrops occur, or can be exposed by erosion. The coarse-textured Alfisols typical of the sub-region are moderately fertile but do not hold water well. Natural vegetation is semi-deciduous to deciduous open woodland. It has been altered everywhere by shifting cultivation and fires.

Important genetic resources of the sub-region include wild and domesticated sorghums and millets, cowpeas, and trypanosomaiasis tolerant cattle,

Coastal fisheries and mangroves in Mozambique are heavily used and threatened by present and proposed dams on the Zambesi river.

The tse tse fly and the black fly vector of river blindness and malaria vectors occur in the sub-region, limiting the welfare of people and cattle. Erradication efforts are underway.

Soil erosion, dwindling firewood supplies, and fires are the major natural resources management problems linked to agricultural development in the sub-region. Also the management of critical upper catchment areas, such as the Fouta Djalon plateau and highlands in Guinea, where the Gambia and Niger rivers arise, is an important need.

Sahelian states with sub-humid forests in their southern extents will be increasingly turning to these for urban charcoal needs. Their remoteness from capital cities is the only brake on exploitation. In the longer term, as tse tse and black flies are erradicated or controlled, this sub-region will predictably receive surplus population from the adjoining semi-arid zone. Inappropriate landuses and intensification of traditional cultivation could lead more quickly to land degradation than in the semi-arid tropics.

African Highlands

The 1500 meter elevation defines the lower agro-ecological boundary of the African highlands, although their physical definition begins in places at around 1000 meters. Average temperatures range from 20 to 16 degrees C in the tropical latitudes, and between 16 and 10 degrees C in the Southern African Sub-tropics. The climate is salubrious for people and livestock alike.

Forests are largely gone, except at higher elevations or where protected. Alpine flora is unique; the white backed mountain gorilla is native to the Rwandan/Zairean volcanic mountains. Only on Mt. Cameroon, however, are montane rainforests found.

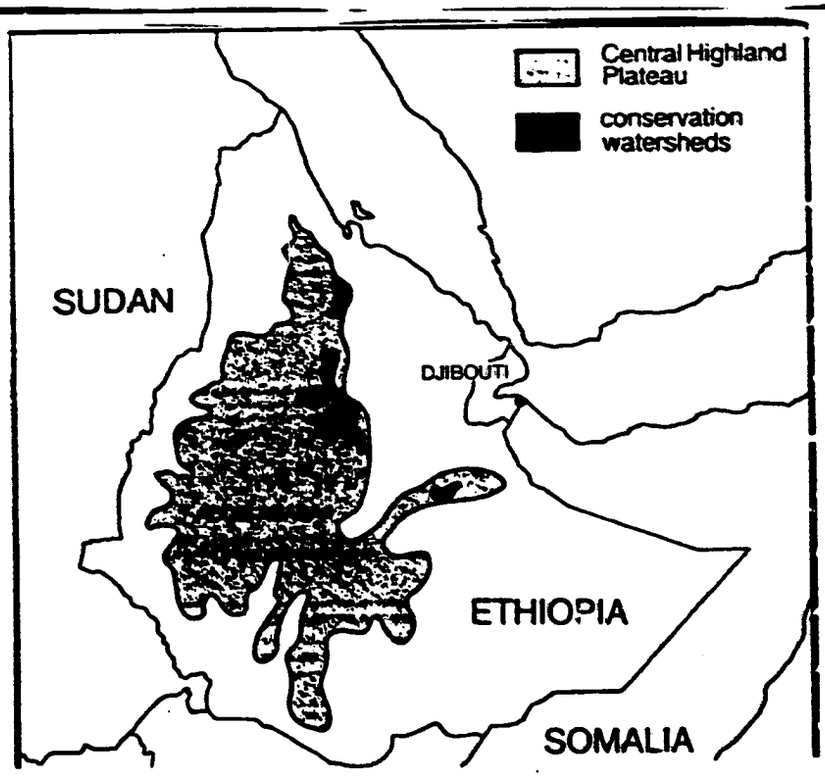
The remaining forests of the Ethiopian highlands contain the wild progenitors of *Coffea arabica*, and are an important reservoir for disease resistance traits.

Dense populations are typical: 75 - 400 + persons per sq km. The Ethiopian highlands harbor 22 million people.

Crops grown are sorghum and millet at lower elevations, bananas and maize over a wide range of elevations, and above 2,000 meters, potatoes, peas, and wheat, as well as tea and pyrethum.

Soils are of variable age, origins and fertility. Rwanda's volcanic soils are the most productive, supporting up to 600 person/sq km .

Soil erosion has long been a problem, which has become more severe in proportion to population growth. One of the largest soil erosion control programs in Africa is underway in the Ethiopian highlands, with assistance from the World Food Programme.



Ethiopia

Kenya is undertaking a broad and apparently successful campaign to control erosion from steep lands. Rwanda and Lesotho also have carried out erosion control programs for many years. Lack of soil erosion monitoring or impact studies throughout the sub-region limits an appreciation of the effects, however.

Many and diverse kinds of projects concerned with erosion control, forestry and fuelwood, agricultural production, soil and topographic mapping, specialized livestock, and fisheries have been supported by governmental and non-governmental organizations alike in the African highlands.

The greatest long term need in renewable natural resource management will be that of entirely arresting erosion, and developing ecologically, socially and economically sustainable landsue systems for population densities that already are stretching or exceeding the land's supporting capacity and for farm sizes that are too small for significant commercial surplus. A parallel need is that of preserving forests on steep upper slopes as well as those already protected as parks.

Humid Coastal Lowlands

This is a densely settled strip on the West African coast, from Nigeria to Guinea Bissau, with 270+ growing season with two rainfall peaks and a 2-month dry season(slightly longer in Guinea Bissau). The coastal cities are growing rapidly, and this is the most urbanized sub-region.

1.0 Soil erosion and declines in productivity

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Two major areas of concern related to the soils resources in Africa were initially identified by the AID Planning Committee:

1. soil loss -- due to erosion by wind and water

2. reduction in soil productivity -- through such processes as desertification, leaching (in humid zones) or salinization.

This review briefly describes in general terms the nature and causes of these two kinds of land degradation, corrective or preventive measures, and approaches by AID and others to applying these measures. Suggestions for actions finalize the review.

The two problems often occur together. Soil loss by erosion results in loss of soil productivity, with few exceptions(e.g. deep, uniformly fertile volcanic or loess soils). In this review, however productivity losses and erosion are treated separately.

Extreme erosion and productivity loss in arid environments leads to desertification. Desertification involves vegetation as well as soils. It will be dealt with in a comprehensive way in the discussion later of the ecological stresses caused by periodic drought.

The coastal strip's clay soils are fragile and easily degraded under cultivation of annual crops. Forests have been largely removed, causing great concern among scientists for the loss of the sub-region's endemic flora and fauna. The coastal forests exist in only small pockets, and have been reduced to 10% or less of their original extent. Grass savannas with poor agricultural potential are found.

Guinea Bissau's mangroves and islands are important resources, and seasonal habitats for migratory birds. They are being converted to rice production, however. Catch statistics suggest that coastal and marine fisheries are not important, except in the Ivory Coast.

Export crops are major landuses: rubber, cacao, and oil palm. grown on small and large scale plantations. Food crops are cassava, maize, yams and rice. Shifting cultivation has converted the original forest to a low brush not exceeding 5 meters, and periods of cultivation are extending while fallows are shortening.

Dry season brush fires set by farmers and herders destroy vegetative growth but damage soils as well, by baking the surface and killing micro-biological life.

Alley cropping techniques developed over the past 8 years at the International Institute for Tropical Agriculture(IITA) at Ibadan, Nigeria, promise to be an effective substitute for fallowing, and thereby stabilize food crop production and soil productivity.

The conservation of remaining forests and existing parks and protected areas is of urgent importance given the state of deforestation. The forests of Guinea and Guinea-Bissau have not been adequately surveyed. Forests and parks management is generally weak.

Humid Equatorial Lowlands

This lightly populated sub-region in central Africa has a growing season in excess of 270 days, but it is less humid than, for example, the Amazon basin. There are two rainfall peaks and over most of the Congo Basin total rainfall is around 2000 mm.

This is the only sub-region that was projected by FAO to not be facing the spectre of over-population by the year 2000. The livelihood of rural people is based on shifting cultivation of cassava, yams, maize, beans and rice, and some hunting and fishing. Zaire harvests 100,000 tons of fish per year from its fresh waters.

The sub-region's 140 million hectares of closed forests(60% of African's closed forests) are characterized by mixed, semi-deciduous species. Over half the continent's plant and animal species are found in the sub-region's forests.

80% of the plants are endemic. For the present unique biological resources are not threatened, although only 5.8 million hectares are protected.

Deforestation is taking place at the rate of 220,000 ha a year -- less than for Ivory Coast alone.

Illegal hunting for export trade in ivory and other animal products is a problem that is not being resolved.

Madagascar and Indian Ocean Islands

This sub-region includes the Comoro and Seychelles Islands and Mauritius, but is dominated by Madagascar, for its size and population(59 million ha and 9 million people) and its floristic uniqueness.

Thousands of species are endemic to Madagascar and are not found on the African continent. They represent a storehouse of genetic wealth. But grasslands have replaced most of the forests.

The other islands also contain a measure of unique flora, and in addition important coral reefs. Madgascar's mangrove forests support important prawn fisheries.

Mangroves are being over-cut in the Seychelles.

Coral reef destruction is serious in the Comoros.

Soil erosion is destroying 1 million hectares of agricultural land per year in Madagascar. 3,000 has of paddy riceland are lost each year to erosion, equal to the amount brought into production. Cyclones occasionally buffet Madagascar, with devastating erosive power.

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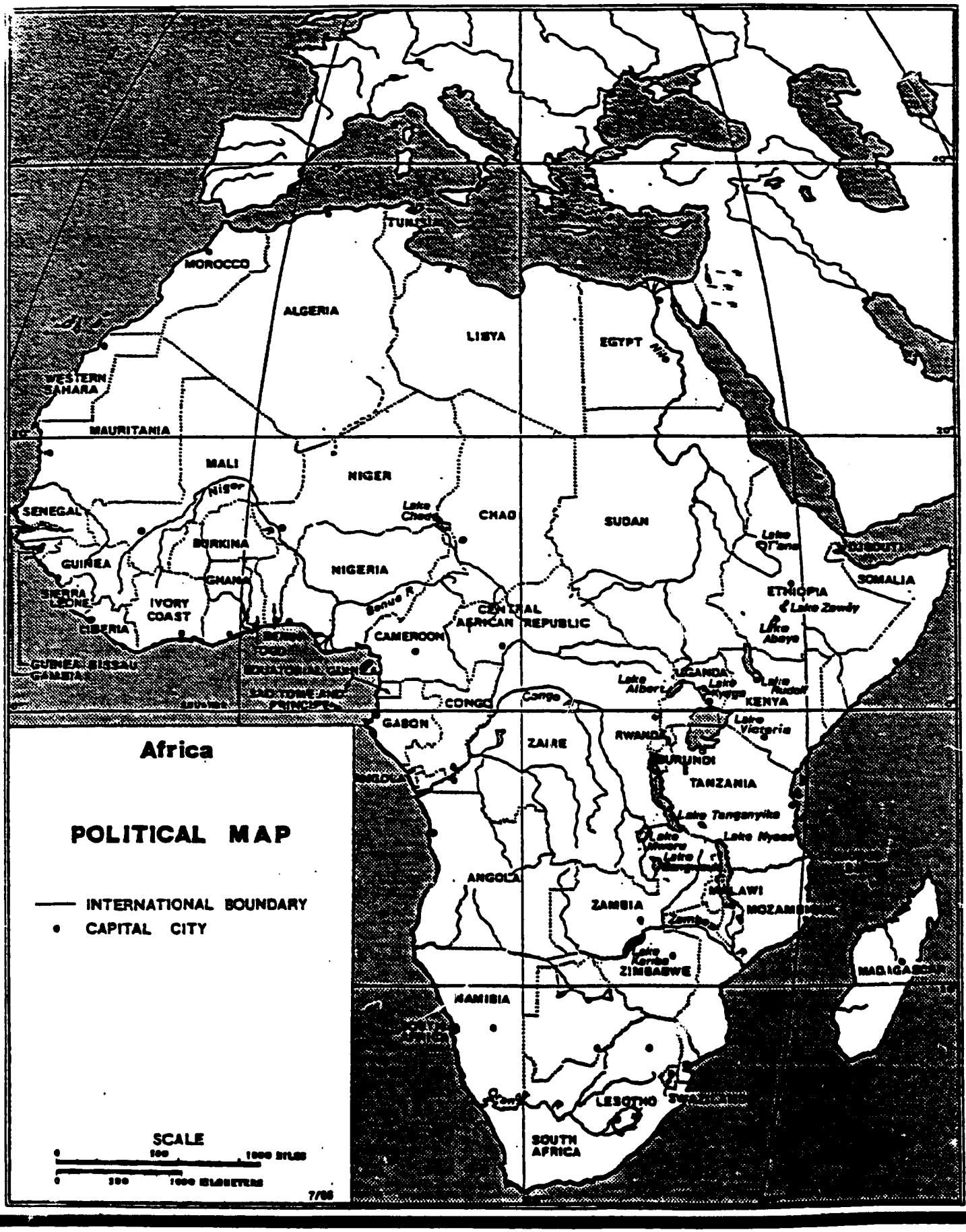
Africa
POLITICAL MAP
INTERNATIONAL BOUNDARY
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SIERRA LEONE
LIBERIA
IVORY COAST
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Lake Albert
Lake Rudolf
Lake Abaya
Lake Zawdy
Congo
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Benue R.

I. INTRODUCTION

The complexity, severity and uniqueness of Sub-Saharan Africa's developmental and environmental situation defies ready comprehension. AID and other donors have expended vast effort and sums whose effects are not easily summed up, so great and diverse are the nations and environments in this huge continent.

A need to better articulate and coordinate AID's approach to Sub-Saharan Africa's environmental problems -- desertification, deforestation, loss of genetic resources, and others reviewed herein -- led to the drafting of the present document and the planning process to which it contributes.

The visible link between human suffering and environmental degradation is nowhere as evident as in Africa. The spectre of so-called African "environmental refugees" fleeing from the ravages of drought and desertification triggered a massive outpouring of U.S. humanitarian assistance to the continent. It has also re-confirmed the determination of those concerned with African development issues that efforts to reduce the region's vulnerability to these and similar disaster must be strengthened.

The Agency for International Development (A.I.D.) has been a major donor in supporting environmental/natural resources programs in Africa for the last ten years. Much has been learned about the problems and modest achievements recorded. This review document examines these experiences and lessons.

USAID intends to maintain a continuing commitment and level of support to the natural resources management needs of Sub-Saharan Africa. This must be a long-term effort, but in the near term there must be a concerted effort to consolidate the present gains and rationalize the approach to natural resources management development programs in the Region.

The dynamic of Africa's environmental decline

As famine struck in 1984/85 after several years of drought, 10 million people in 20 African countries were forced to abandon their land and seek relief. Another 20 million in these same countries of Africa's extensive arid-semi-arid zones were judged to be at risk by the United Nation's Office of Emergency Operations in Africa. Two billion dollars of relief assistance was needed to stem the tide of death sweeping the Region.

One can only speculate, however, on how many of these people were victims of the fatal combination of drought and desertification. In vast areas of this zone of Africa, the sparse rainfall fell on highly degraded areas - stripped of vegetation by land clearing, overgrazing and fuelwood collections, with soils eroded by wind and water and depleted of organic matter and nutrients by continued cropping with inappropriate agricultural practices. Drought in Africa is recurring and unpredictable but its impact is directly linked to the condition of the lands were it occurs.

Desertification is perhaps the most visible of Africa's environmental problems. There are many others, slower, less dramatic, and more pervasive, inexorably eating away at the the fabric of the ecological balance on which Afirca's destiny must be built.

The promise and potential of East Africa's highlands where soil quality and favorable climatic conditions mean good productivity, is already severely undermined by population pressure leading to small farms, reduced fallow and massive erosion (over 50 tons/ha/yr. in many areas). Extensive portions of Ethiopia's high plateau have already been so degraded that huge sums must be diverted from development programs to undertake extremely costly rehabilitation works.

Semi-arid Africa's precious water resources present complex management problems. Three of the major rivers of West Africa - the Senegal, the Niger and the Gambia - which represent a significant portion of this subregion's future irrigation potential, rise in the Fouta Djallon Plateau of central Guinea (Conakry). Yet this area too, with its fragile soils, has also been a victim of too many people practising poor land husbandry. Sheet erosion,nutrient leaching, and reduced fallows have halved the production (from 600 kg. to 300 kg. per hectare) of even the "fonio" (Digitaria exilis), the poor grass-like grain crop now employed by the subsistence farmers

on these impoverished and acidic soils. This is only one of Africa's major watershed areas where, both upstream and downstream, negative impacts are directly affecting development potential.

The problems of Africa's rich natural resource endowment are also visible in the rapid decimation of its magnificent wildlife heritage. Elephant populations in Kenya have declined from 160,000 in 1963 to 60,000 in 1983 despite the country's extensive system of parks and preserves. The Africa rhino in Tanzania and Kenya, reduced from over 6,000 in the mid-seventies to less than 350 in 1980, must now be intensively nurtured by man to survive as a species.

If indeed natural areas with their flora and fauna must give way to accommodate man and his needs, this must take place without endangering the biological diversity which underpins the world's common gene pool and its evolutionary survival.

Nowhere is the world's biological diversity more threatened than in Madagascar where the destruction of only a few hundred hectares may mean the extinction of an endemic plant or animal species. Much of this habitat loss is the result of fires and shifting cultivation which after decimating the rich flora and fauna will also continue to weaken the existence of another threatened African species - man himself.

These few examples are inadequate testimony of either the complexity of the problems or the variety of the ecological conditions which characterize the vast African continent. It is clear, however, that a better understanding of African environments and the relationship to and impact of human activities will be required if development agencies are to effectively assist Africa's governments and its people to cope with the present degradation and avoid exacerbating it in the future.

Recent Initiatives

A.I.D. projects dealing with natural resources in Africa date back to the 1950's when PL-480 funds were used for a variety of reforestation efforts, albeit particularly in North Africa.

The Sahelian drought of the late sixties/early seventies coupled with governmental (African and donor alike) recognition of the environmental degradation factor in development stimulated new impetus to A.I.D.'s interest in natural resource management. Fuelwood harvesting was considered to be a particularly important causal agent of environmental degradation, and a new generation of projects, emphasizing reforestation, were launched.

Over the past eight years, A.I.D. has committed a total of approximately $300 million (more than a third of which PL-480) in forestry and closely related natural resources and renewable energy projects for sub-Saharan Africa. These figures do not include the substantial sums invested as part of larger agricultural and rural development efforts which addressed such basic natural resources concerns as soil and water. Likewise these projects were not restricted exclusively to rehabilitation efforts but also focussed on building host country capability through training, education and institution-building, improved planning and land-use inventory and on limited amounts of research.

In the period 1978-1981, the Agency helped to underwrite a series of 21 environmental profiles of African countries prepared in conjunction with US/MAB program. These reports, largely desk studies were seen as early steps in a process to develop better information for A.I.D. missions, host country officials and others, on the environmental situation in each country and to identify critical areas of concern.

A series of policy statements, general guidance and planning documents issued in the last five years have also enhanced the Agency's role in environmental and natural resources management. These have included items of both a general and Africa specific nature:

Policy Determination 74 - A.I.D. Forestry Programs and Policies (April 1981),

the Agency Sector Strategy for Environment (Nov. 1983),

the Agency Sector Strategy for Forestry (Feb. 1984),

the Africa Bureau Strategic Plan (July 1984),and

the Plan for Supporting Agricultural Research and Faculties of Agriculture in Africa (May 1985).

Each in its turn has emphasized the importance of the natural resources component in the development equation and recorded the evolution of Agency thinking and planning to address this sector.

The recurrence of devastating drought and its direct correlation with environmental degradation has prompted the need for the present plan. It comes at a time when there has also been considerable introspection into the appropriate mix and action priorities both for the natural resources sector and for African development in general, not only within AID but throughout the donor community.

American foreign assistance programs in Africa have expanded dramatically in recent years. A.I.D. now provides about $800 million annually in economic assistance to 41 countries in the Region. This represents a fivefold increase in assistance levels since 1974 and a 50% increase since 1981.

Changing political and economic trends, drought and other emergencies and evolving U.S. foreign policy objectives have accounted for significant shifts of U.S. assistance to African countries. Assistance levels are likely to continue to fluctuate but the Agency is making a determined effort to focus attention and resources on the most important issues and to maintain a dynamic program approach over the near and medium term.

A.I.D.'s programs for Africa over the next several years will continue to be directed at three major priorities - economic restructuring, human resources development and agricultural production and market development. These priorities reflect those of the Africans themselves as witnessed by the action resolutions emanating from the recent United Nations General Assembly Special Session on the Critical Economic Situation in Africa (May 1986). They recommended attention be directed to: eonomic reform and structural adjustment, priority attention and resource commitment to agricultural rehabilitation and development, promotion of sectors supportive of agriculture and rural development, efficient development and utilization of human resources, and continued attention to the problems of drought and desertification.

Attention to the natural resources base for agricultural development is also a concern of African governments. At the First African Ministerial Conference on the Environment, held at Cairo, from 16 to 18 December, 1985, it was decided to strengthen cooperation between African governments in economic, technical and scientific fields. The prime objective being the halting and reversing the degradation of the African environment in order to satisfy the food and energy needs of the peoples of the continent.

A Long Term Plan for AID Support to Natural Resources

At the direction of the Administrator, an intra-Agency group has been working to elaborate an A.I.D. Plan for Supporting Natural Resources Management in Africa. This plan is being prepared to guide the Agency, its Bureaus and Missions in analyzing, integrating and choosing natural resources programs and activities as key elements of the Agency development strategy for the region.

The goal of the plan is to provide a framework for a more coherent and effective long-term AID response to needs in natural resources and environmental management

The inter-actions of the Plan and agricultural development will be explicit. There is overall agreement between the U.S. and its host country partners that agriculture should be the primary "engine of growth" in Africa in the near and medium term. However, agricultural productivity will require special attention to restoring or maintaining environmental stability so as to protect soil fertility and ensure the integrity of water resources.

The linking of natural resources management and agricultural development will mean increasing attention and support to a series of actions pragmatically integrated into current development efforts, including: better land-use planning; controlling devegetation and deforestation; enhanced natural resources management; rehabilitation efforts to reverse environmental degradation through soil and water conservation and tree planting; and a concommitant program to strengthen national understanding of environmental issues, to improve policy and to build on the present emerging institutional structures for these programs.

The plan that will be developed will serve as an analytical benchmark and baseline for future assessments of the program and its priorities. It is also designed to help assess U.S. comparative advantage in the natural resources sector by suggesting how American tools and technology can be brought to bear on the problem and isolating research needs where these appear to be serious constraints to future development.

The Planning Process

A working group has carried out a careful sequential analysis of the situation. This has included the following steps:

- The Africa Region has been divided into a series of coherent agro-ecological zones and an assessment of the major environmental-natural resources problems, including descriptive narrative statements, assembled for each;

- Considerable effort and reference material gathered to permit a cartographic expression of these issues so as to define zones of action and interlinkages between them;

- Interviews and communications with other donors to identify the present scope and primary concerns of their African environmental programs;

- A comparison is being carried out in broad terms comparing the problem assessment with ongoing programs to identify the action gap; and

- Analyzing this gap, choosing a practical action plan for A.I.D. based on U.S. capabilities, ongoing programs and interests and assessing, broadly, the resources (human and financial) to carry out this resulting plan.

The analytical background documents have been completed and the working group is embarking on a series of reviews, both internal and with a panel of outside experts.

Present Review Document

This review of natural resources and environmental management problems was prepared during May to August, by three technical staff from the Bureau for Science and Technology and the Bureau for African Affairs. It will be modified and revised following workshops and reviews in August in and outside of AID.

The review has attempted to compile and synthesize relevant literature, AID documents and studies, and other work in progress. A special effort was made to take into account recent evaluations by AID or other donors of natural resources project assistance in Sub-Saharan Africa.

There are nevertheless important gaps. The institutional situation in the 33 African nations where AID presently has development assistance programs could not be reviewed adequately from Washington D.C. Subsequent reviews of this document be AID field missions will hopefully correct this deficiency. Recent research results in agriculture that could alter prospects for production increases, and make additional demands on the resources base, were not systematically analyzed. A merging of AID agricultural planning with the present effort is scheduled. Finally, all donor activity could not be surveyed (Annex A, and B) nor could adequate justice be done to the explanation of various AID projects at the country and regional levels. However, the latter will be remedied in the course of reviews.

Presentation of the review

Section II present summary analyses of the seven natural resources issues that were identified as important by the Planning Committee:

* soil erosion
* soil productivity -- loss
* vegetation -- loss or degradation
* water resources -- degradation by pollution, salinization, etc.
* biological resources -- loss, decline of diversity
* coastal resources -- loss, degradation
* stresses on natural resources due to drought

Section III reviews these issues in greater depth for seven sub-regions that were identified on the basis of agroecological criteria, population pressures on natural resources, and biological uniqueness and diversity.

Annex A presents a survey, by individual country, of donor support for natural resources and related environmental support. Annex B reviews multilateral assistance in these areas.

II. NATURAL RESOURCES MANAGEMENT ISSUES IN SUB-SAHARAN AFRICA

A. Introduction

The seven critical natural resources management problems that were identified in the preparatory phases of this planning document are analyzed in this section. For each issue the following aspects were treated:

* short definition or summary description

* review of the state of knowledge of the issue

* trends, gravity of the issue, implications for development

* known management or development responses, including lessons learned from past experiences in development assistance, and a brief review of the kinds of assistance or actions AID and other development agencies are currently supporting.

A fuller accounting of development assistance responses is provided in the sub-regional descriptions(Section III).

The two issues dealing with soils - erosion and fertility decline - are treated jointly.

1.0 Soil erosion and declines in productivity

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Two major areas of concern related to the soils resources in Africa were initially identified by the AID Planning Committee:

1. soil loss -- due to erosion by wind and water

2. reduction in soil productivity -- through such processes as desertification, leaching (in humid zones) or salinization.

This review briefly describes in general terms the nature and causes of these two kinds of land degradation, corrective or preventive measures, and approaches by AID and others to applying these measures. Suggestions for actions finalize the review.

The two problems often occur together. Soil loss by erosion results in loss of soil productivity, with few exceptions(e.g. deep, uniformly fertile volcanic or loess soils). In this review, however productivity losses and erosion are treated separately.

Extreme erosion and productivity loss in arid environments leads to desertification. Desertification involves vegetation as well as soils. It will be dealt with in a comprehensive way in the discussion later of the ecological stresses caused by periodic drought.

1.1 Background

The driving forces behind these two forms of land degradation are: (1) extension of cultivation into marginally productive lands susceptible to erosion, and (2) increasing frequency of cropping of fields that in the past were fallowed to restore fertility. Both forces are, in turn, driven by rural population growth and to a lesser extent, the addition of commercial crops(e.g. peanuts, cotton, tobacco, maize) to the traditional suite of food crops, by cultivating larger surfaces and using animal drawn implements. The drought has accelerated the effects on the land resource of these trends.

Cropland expanded from 113 million hectares to 142 million hectares during the period 1966 and 1985, mostly coinciding with the worst drought of the century. Much of the expansion took place in arid and semi-arid regions. In the West African Sahelo-Sudanian belt 3.8 million additional hectares were put into cropland(Source: WRI, 1986, Table 4.2), at a time when wind and occasional water erosion were especially serious. In Ethiopia 2.2 million additional hectares were cleared and cultivated during 1966-85, doubtless much of them on steep uplands.

Colonial and newly independent African governments alike have taken steps to arrest soil erosion. Yet apart from several recent exemplary successes in combatting erosion -- including among others AID-supported watershed treatement in Cape Verde and World Food Programme erosion control work in Ethiopia -- it continues to be a grave threat to the sustainability of agriculture in Africa.

Declining soil fertility is a more widespread, insidious problem that lies directly in the path of agricultural progress in Africa. No breakthroughs are on the horizon for arresting declining soil productivity in the arid and semi-arid tropical zone. But in the humid coastal and equatorial lowlands, eight years' of research in alley cropping at IITA with Leucaena leucocephala and other trees, holds forth the promise of a subsistute for traditional forest fallow to restore soil fertility(Kang, Wilson and Lawson, 1984).

There are no overall statistics on intensity of cultivation, that quantitatively reveal the shortening or abandonment of fallow cycles, as a clue to the loss of soil productivity due to this trend. However, in the computations of population supporting capacities for various agro-ecological regions in Africa(FAO, 1982), FAO assumed a cropping:fallow cycle of 1:5. This has been greatly exceeded in many places, and isn't

adequate for the more humid tropics. The result can only be a decline in productivity. Areas where population has exceeded sustainable levels of cropping intensity under traditional systems were identified by FAO as over-populated(See fig.).

The threat of erosion from wind and water as well as of desertification in general have been assessed and mapped by (or for) FAO in recent years(FAO and UNESCO, 1977; FAO and UNEP, 1984).Annex C describes these efforts, their limitations and their promise. At the time of this plan diagnosis the FAO soils degradation studies had not yet been brought into a useful analytical or cartographic form.

Africa's soils are not well described and mapped. FAO's 1:5,000,000 soil map of Africa is for the moment the continent-wide standard. The scale is far too small for any but the most general planning. Additional larger scale surveying is going on, based on either the French (Aubert's) soil taxonomy or the USDA taxonomy, whose use is being constantly extended with assistance from USAID's Soils Management Support Service (Bureau for Science and Technology). The observed variabilty of soils over short distances as well as the small size of most farms and fields, used mainly for subsistence foods, elevate the costs a depress the benefits of soil mapping in Africa. It appears that cheap, rapid techniques of soil mapping and description, perhaps by better use of aerial photography, are a needed response.

Box

Land and landuse statistics

Large differences characterize various estimates of potential and actual cropland in Sub-saharan Africa.

Cropland in 1971-5. (WRI, 1986, p. 47 Table 4.2)

Actual and potential cropland: 760.5 million hectares

Cropped: 160.5 million hectares (1975)

Cropland 1965 and 1983. (WRI, 1986, p. 256.Table 4.1 Land Use, 1964-85 based on FAO surveys)

Arable and permanent cropland , including temporarily fallowed land as well as cacao, coffee, rubber, etc. plantations)

1964-66: 113 million hectares (all Afr. 148)

1981-83: 142 million hectares (all Afr. 178)

Increase: 29 million hectares

The 1983 total is less than the 1975 estimate taken from the Global 2000 report, and derived from USDA statistics.

Much of the above increase occured in arid and semiarid Africa:

Senegal	768,000 hectares
Mali	1,220,000
Burkina Faso	548,000
Niger	1,267,000

Large percentage increases occured in densely populated nations:

Rwanda	from 21% to 26% of the total land base
Burundi	from 39% to 41% of the total land base

Lesotho suffered a net loss of cropland in the 17-year period. It lost 60,000 hectares, equivalent to 2% of the land base, and 17% of the cropland.

Possible erosion losses:

The potential loss of rainfed cropland in all of Africa to wind and water erosion between 1975 and 2000 was estimated by FAO(FAO, 1984). If no conservation measures are taken, a total of 203 million hectares will have been lost, or 16 % of the total (estimated for all Africa to be 1,268 million hectares) Erosion would also have impaired the productivity of the remainder.

End Box

1.2 Soil Loss by Erosion

Because most soils in Africa are very old and highly weathered, i.e. with deep relatively infertile horizons, loss of topsoil is of the gravest consequence. Newer, more fertile soils tend to occur in steep landscapes, i.e. the East African and South African highlands, where they are susceptible to disastrous erosion, which only the deepest fertile volcanic soils can withstand for any period of time.

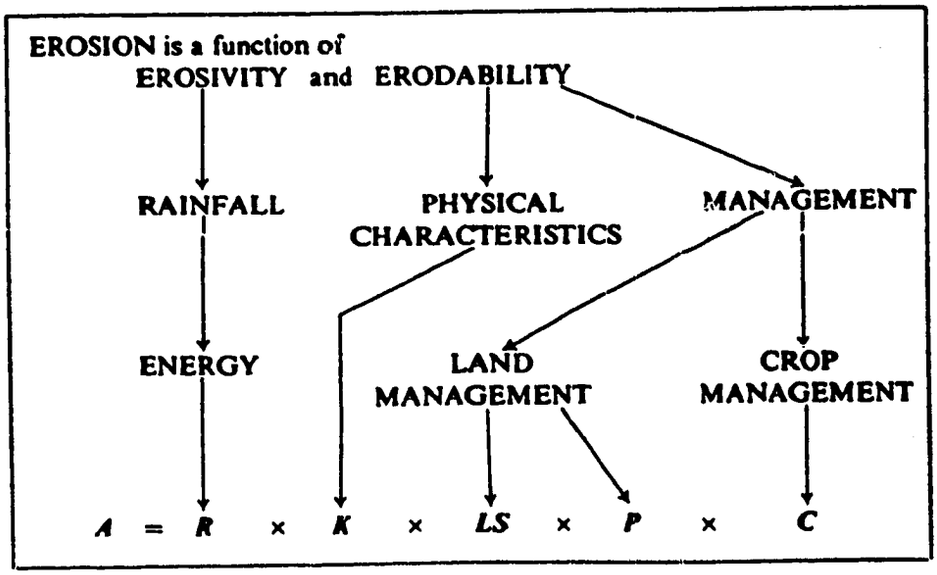
State of knowledge:

For a problem so grave and so important for the well-being of African people, we possess a striking paucity of solid information.

Very little research or measurements of rates of soil loss or rates of soil formation have been carried out in Africa. In 1984, FAO and the International Institute of Applied Systems Analysis computed estimates of productivity losses due to erosion, based on 160 sites in Africa, but the results were not seen during the present review(Shah, Fischer, Higgins and Kassam, 1984). Similarly, virtually no research or evaluations have been done on the effect or impact of erosion control on long term soil productivity.

The number of variables involved in erosion by water are numerous: rainfall energy(intensity), soil characteristics (including degree and length of slope), land management and crop management(see fig.). Quantitative measures of soil loss, usually expressed as metric tons per hectare are often meaningless, for lack of mention of period of observation or of the above variables. Nor is it known how much erosion can be accepted.

Without a knowledge of rates of soil formation, tolerable rates of loss cannot be known. To date, rates of loss judged acceptable in the U.S. have been used in the few calculations made (Lewis, 1985).



The structure of the universal soil-loss equation

Altnough an apparent contradiction, water erosion in arid and semi-arid as well as sub -humid Africa is the principal cause of soil loss. This is due to the unusual intensity of some storms as well as the sparseness of vegetation in the more arid climatic regimes. In the gently sloping lowlands of West Africa's Sahelo-Sudanian region, water erosion is considered a major threat(WMO, 1983, p. 106 cf), especially if it exposes lateritric horizons. Losses of 12.5 tons per hectare per year from fields with only 2% slope, planted in peanuts were measured(WMO, 1983).

Generally speaking, in Africa, the soils most susceptible to erosion are also the lands most heavily, or over-, populated, i.e. the arid and semi-arid regions and the highlands of East, Central and Southern Africa. The tiny country of Lesotho in the Subtropical Highland of southern Africa is indicative. There the average soil depth is estimated to have been reduced by 10 centimeters or 25%.

In addition to the physical removal of soil by water erosion of various types(sheet, rill, gully, etc.), damage to soil structure from the impact of rain drops renders soils less porous, increases surface run-off, and as a result, surface erosion.

1.3. Erosion Control Methods

Techniques of soil erosion control are well known and have been widely published by FAO and others(FAO,19 , Weber and Hoskins,198 ;SCS,). They include bunds, infiltration ditches, terraces, gully plugs and low dams, to arrest the energy of run-off water; palllisades and windbreaks to arrest wind energy, and ground cover of various sorts, according to the ecological possibilties.

Water erosion control works are often multiple purpose: they retain soils, but also slow run-off and increase percolation, thereby conserving soil moisture. Finer sediments of clay and loam important to soil productivity are retained.

Large scale projects,i.e. of entire watersheds, entail proven planning and layout techniques, especially in areas of diverse soils requiring different techniques to achieve the same purpose.Less well known are ways to engage small farmers and villages in soil erosion works that they can plan and carry out on their own, and which will bring perceptible benefits.

It is worth noting here that planting trees alone does not prevent erosion by water i.e. run-off erosion. Only ground cover consisting of grassy or herbaceous vegetation can effectively control water erosion. Trees, or other woody plants may be established on terrace walls or bunds to stabilize them, and the crowns do intercept rain drops and lessen their erosive impact. However, an over-grazed tree plantation can become as serious eroded as an open field if the terrain is steep.

Soil conservation programs have tended to focus on preventing water erosion moreso than wind erosion. In Africa, wind erosion is dramatized by moving sand dunes. Concern over sand dunes encroaching onto croplands or settlements and wind damage to crop vigor have motivated control works moreso than concern over actual soil losses. Nevertheless, the blowing away of smaller particles of clay, loam and organic matter insidiously reduces soil fertility.

Responses to the problem of soil erosion are likely to have to resolve soil fertility limitations to render the efforts worthwhile. For instance, in humid environments bench terracing may initially decrease soil fertility because it disorganizes the soil horizon, and terrace walls will remove up to 25% of the land surface from cultivation.

In the short to medium term, fertilizers may be needed to compensate for lost production of control works or to render economical the labor input. On the other hand, soil erosion control can also increase productivity. The shallow ridges lining infiltration ditches dug on slopes in Burkina Faso collected silt and organic matter and yielded far more sorghum in a narrow strip(initially) than farmers had seen on untreated sloping fields. They readily extended on their own initiative the infiltration ditch activity begun by an Oxfam worker.

Possible Box

Given the primordial importance of the first 8 to 10 centimeters containing organic matter, humus and most of the microbiological life that lends productivity to soils, and given the time and effort required to reconstitute this layer of "living soil" once it is lost, the loss of even one half of this layer is serious. Assuming a soil density of .7, the weight of the first 4 centimeters of a hectare of soil would equal 280 metric tonnes, i.e. 65 tonnes per centimeter. In Ethiopia, for comparison, rates of 152 to 165 tons/ha per year have been measured. 224 tons/ha per year have been measured in Lesotho (El Swaify, 19 , and Turner, 19 , cited in Sfeir-Younis, 1985). .

End box

1.4 Soil productivity declines

Fertilizer use in Africa is the lowest of any continent, due to a plethora of factors. It would be surprising indeed if there were not a loss in soil productivity. However, productivity of cultivated soils, including those used for growing trees, is a function of more than fertility as measured by the major nutrients, i.e. N, P, and K. It is also determined by organic matter and humus, cation exchange capacity, toxic amounts of salts and other elements, e.g. aluminum, manganese), soil organisms, and various physical features, i.e. porosity, drainage, and field capacity(for water).These characteristics vary widely as a function of the various soil forming factors: parent material, climate, vegetation, time and mankind's actions.

Leaching of nutrients, formation of laterite, phosphorus fixa? tion, loss of cation exchange capacity, salinization or water-logging, infestation by plant parasites or inerradicable weeds: these are some of the diverse ways in which soils productivity is lost, temporarily or permanently.

State of knowledge:

Knowledge of soil productivity loss due to causes other than erosion is patchy. No general surveys for Africa were found, outside of Nye and Greenland's classic **The soil under shifting cultivation** (Nye and Greenland, 19).

Given the numerous causes of productivity loss, it would be prohibitively expensive and complex to develop a statistical picture of productivity trends. Low or declining crop yields are not a reliable measure since other factors such as rainfall, weed competition, seed sources, pests and disease also affect yields.

Detailed knowledge of African soils, e.g. at the level of the farmer's field, is very poor; large scale soil maps are lacking for most of SSA; knowledge of chemical and microbiological aspects of productivity is very sparse; knowledge of crop responses to various kinds and levels of fertilization is scarce.

The problems of semi-arid or sub-humid zone soils are perhapsbetter known and documented than those of the humid to perhumid zones(e.g. Charreau. ; Dregne, 1982, Kowal and Kassam, 1978).

FAO has convened numerous seminars or conferences on the theme of soil fertility in Africa:

1970. Conference on Soil Fertility and Fertilizer Use in Africa (Addis Ababa).(FAO, 1970)

1977. FAO/SIDA Workshop onthe Use of Organic Materials as Fertilizers in AFrica, Buea, Cameroon. (FAO, 1977)

1980. Seminar on Recycling of Organic Agricultural Residues in Africa, Lome. (FAO, 1980)

African soils are extremely diverse, but a few generalities can be made.

The productivity of older soils is highy variable, even within small fields in Africa.

In the humid tropics phosphorus fixation in clay minerals and laterization, following exposure to the air due to cultivation and erosion, are but two examples of the numerous soil management concerns. Toxic levels of aluminum and manganese may also affect older soils, and can result from continuous cultivation with fertilitzers.

A downward trend in soil fertility is taking place, according to yield statistics and farmers' observations. However, yields trends sum up a great many factors and are a poor indicator of soil productivity.

Water-logging and salinization are not yet widespread problems in SSA irrigation projects. Outside of Sudan, there are few large irrigation projectgs, but the threat is always present, especially where drainage is poor, such as in some small projects on the on the Senegal river.

In the different sub-regions the mechanisms of productivity loss vary, being a function of soils, climate and related agricultural uses. They are treated in further detail in the sub-regional descriptions.

1.5. Responses to productivity problems

Responding to the various problems besetting soil productivity in Africa is far more complex than responding to soil erosion. Many more interacting factors are involved, in addition to the socio-economic ones regarding farmers' motivations to do something about erosion or productivity loss. High costs of chemical fertilizers are a major obstacle to correcting some infertility problems.

African farmers appear to be slow to develop new techniques of intensification of production, i.e. of increasing continuity and amount of harvests from farmlands, although there are some exceptions. Manure and plant materials have been employed traditionally in many parts of AFrica to enrich soils, especially in fields adjoining settlements or groupings of houses, and permit continuous cropping. However fallowing has been the main means of restoring fertility, especially of outfields. An additional technique in the semi-arid tropics of West Africa is the seasonal corraling of herds managed by Peul nomads on fields of sedentary farmers, to concentrate manure and enrich the soil.

Fallowing can no longer be practiced due to land shortage resulting from population growth and the addition of export crops to the usual subsistence food crops. Apart from alley cropping in the humid tropics, a subsitute means of soil fertility maintenance has not evolved. Fertilizers are too expensive for most crops grown by African farmers, at least under current commodity pricing policies. These policies are recognized to be inhibiting food crop production increases, but many other complicating factors combine to prevent intensification of production.

The management of soil productivity is integral, of course, to intensification of production. The high cost of fertilizers, especially applied to food staples, has undermined this technology for fertility management. However, if cash crops such as cotton are rotated with food crops such as sorghum or maize, the latter will benefit from residual fertilizer.

Beyond the actual lack of money to buy fertilizers, their availability in the correct formulations and timing and the existence of private or public institutions that could supply fertilizers and finance them are additional considerations. Even when farmers can afford them, namely for export crops, fertrilzers may be unavailable or delayed.

If prices and price policies affecting food crops and fertilizers encouraged their use, other limitations to soil productivity would quickly come to fore. The three macro nutrients(nitrogen, phosphorus and potassium) are not the only problem. In the Sahelo-sudanian belt, water holding and nutrient holding capacities(field capacity and C.E.C., respectively) are often limitations.

Soils scientists are nevertheless continuing to seek improved ways to manage African soil fertility with fertilizers. At the same time the possiblity of soil productivity management through means other than chemical fertilizers and its positing as a major objective of assistance has begun to introduce major new elements into projects and research.

Low input alternatives are being sought. Recently experiments with alley cropping using N-fixing legumes offer the promise of a viable substitute for fallowing in the sub-humid and humid tropics(IITA, 1986). However, leguminous trees crop don't resolve phosphorus and potassium deficiencies, nor are they the best source of carbon for restoring humus.

1.6 Development assistance reponses to soil erosion and productivity losses.

The international community has come to the assistance of nations with serious, even catastrophic, soil erosion problems, such as Ethiopia. But little is being done to arrest more insidious erosion and productivity losses that are widespread and less dramatic.

The economic costs and benefits lf conservation and rehabilitation work are now being examined by the World Bank, in major planning study, underway in the Bank's Projects Policy Department. The outcome promises to provide the economic rationale and policy instruments that have long been missing for long term land conservation work.

Responses in the international community to productivity declines have been less dramatic, and have been limited mainly to research. Decades of research in Francophone Africa have revealed the importance of soil organic matter and humus for maintaining cation exchange capacity and preventing acidification of fertilized soils(Charreau, 1986). Phosphate deposits are found in many African nations, including those in the semi-arid and sub-humid zones where soil phosphorus deficiencies have been identified. However, costs of conversion into phosphate fertilizers are too high for the average African farmer and the rock or the fertilizers are exported rather than used locally(e.g. phosphate fertilizers from Senegal, rock from Togo)

IFAD (International Foundation for Agricultural Development) recently contracted the International Fertilizer Development Center, based in Alabama, to set up a research program in Africa, designed to work with various national and international research centers to:

* Evaluate the potential of indigenous phosphate deposits for direct application of phosphate fertilizer at minimal cost.

* Study the role and efficiency of nitrogenous fertilizers

* Study the effect of cropping systems and farm management practices on the maintenance of soils productivity and fertilizer use efficiency.

Partially acidulated phosphate rock was found in field trials to be a viable alternative to single superphosphate -- presently imported from outside the continent. It could be produced and supplied at 80% of the cost of single superphosphate.(IFDC, 1985).

AID responses

AID has responded intermittently over the years to soils and water conservation needs in Africa, but without discernible or purposeful cohesion and momentum.To date there has not existed a programmatic framework for attacking the above problems of erosion and productivity loss(and fertility management). Various recent or on-going projects are, however, dealing with some of the causes. The brief review here is supplemented by additional details in the sub-regional treatments.

On-going or recently completed AID actions include support to World Food Programme soil and watershed conservation projects;grants to PVO's engaging in soil erosion control; technical assistance in soil surveying and classification; and various PL 480 projects managed by AID missions that support erosion control.

AID actions on the soil conservation front have been channeled largely through the World Food Programme or mission managed activities funded out of the P.L. 480 program. The latter have included a very effective project of total watershed treatement in Cape Verde's Santiago Island and dune stabilization with vegetgation in Mauritania and Senegal's coastal zone north of Dakar. In Kenya and Rwanda a subproject activity within the Environmental Training and Management for Africa project measured actual erosion losses from a number of farmers' fields for the first time. CARE's Majjia valley windbreak project is partly supported by AID.

The occasional evaluation of soil erosion control projects provides striking insights as well as evidence of erosion control benefits.

In Somalia, for example, AID recently evaluated a soil and water conservation project undertaken in the early 60's(AID, 1985).Bunded fields were still producing 50% more than those not treated (initially production doubled), even though in many places the bunds had deteriorated for lack of maintenance. Bunded farms also dropped the traditional grain pasture rotation in favor or continuous cultivation of sorghum and increased amounts of maize. Such evaluations are the exception, however.

S & T's Soil Management Support Service is addressing several aspects of the fundamental problem of poor knowledge of the soils resource in Africa: lack of surveys and lack of information for assessing the possibilities of technology transfer from more developed agricultural technologies on similar soils elsewhere in the world(or Africa). Shortterm technical assistance has been provided on survey and classificatory procedures to various countries in Africa: Zambia, Rwanda, and Burundi. Also the problems of dryland agricultural soils are being addressed in an S & T project that includes Africa's Sahelo-Sudanian zone(Project on Dryland Agriculture).

Several AID bilateral projects have supported national, small scale soil mapping and evaluation(Senegal, Mali, and Mauritania). With some AID support the U.S. Soil Conservation Service is up-dating 1:1,000,000 soil maps made of certain ns of Africa 40 years ago on the basis of photo-interpretation of small scale aerial photographs. The result was a land systems map based on geomorphological traits.

Compared to the obvious urgency of the problems of soil manageent, however, and their widespread occurence, AID actions to date have been very small scale, and AID is a relatively minor actor in the arena of soil conservation, research, surveying, and fertility management. On the other hand, there is no major agency outside of FAO's Land and Water Division, that is equipped to provide technical assistance on the many facets of the soil resource.

1.7. Constraints and Gaps

A major, still to be solved constraint on a development assistance response to soil erosion concerns the appreciation of its benefits, by farmers as well as development assistance authorities working at the programming and policy levels.

The predominance of subsistence agriculture in rural Africa creates a paradox. There is little apparent pay-off for government investment in stabilizing the soils of subsistence farmers. Still, subsistence farmers will and do produce commercial crops such as peanuts and cotton; they live in watershed areas; and they will move to cities or other areas if their soils are exhausted or ruined by erosion.

Additional labor is implied for conservation work, e.g. the construction of berms or infiltration ditches along contours.Also there is an opportunity cost of having to construct earthworks after the onset of rains when the soil can be worked, but at a time when other tasks require labor. The increased production of subsistence food, e.g. millet, sorghum or maize, could have to clearly justify the needed labor. GTZ has calculated this justification for dryland farming in the Sahel(GTZ, 1986).

Even at low productivity of dryland millet cropping, i.e. 400 kg/ha, GTZ computed that an increase of from 24 to 77 kg per hectare would compensate the labor cost of berm construction. Prewliminary experiments pointed to increases of 30% to 50% by this method alone(GTZ, 1986, p. 110). Similar assessments of the benefits to subsistence food production of conservation works are needed in other environments of Africa.

As regards the buttressing of policies, the World Bank is pre? sently undertaking a series of studies which aim to elaborate modified costs:benefits analyses and policy instruments which are supportive of soil conservation -- and other conservation management efforts.

The parallel needs to intensify agriculture as well as reverse land degradation compel coordination of responses and interventions at the field and farm level, as well as among services and institutions. This coordination has not yet been achieved anywhere.

In the individual field, priority should be accorded to perfecting techniques that restore or conserve soil and water while at the same time increasing yields. In fact, such conservation normally increases yields, in not initially then within a few years.

Research agendas need broadening. The integration of additional land and crop productivity enhancing techniques -- e.g. use of agroforestry species such as ?Acacia albida?, rock phosphate fertilizer, legume/cereal crop rotations, sowing of improved forage species, and more effective use of crop residues and

manure to maintain soil productivity -- at the farm level has been advocated but not yet achieved in formal research and development experiments. Individual elements are being researched and developed; this is inevitable and needed. Different combinations and configurations, i.e. systems, must be researched next. Farmers themselves are no doubt innovating with different elements that they learn about or obtain(e.g. improved varieties).

Equally urgent and not less difficult is the need to more effectively coordinate and deliver various government services so as to support improved systems that both conserve the resource base and increase production. Much work, some unprecedented in the industrial world, is needed in this respect. That being true, the work will be exploratory. In all likelihood a partnership relationship must be developed between government institutions and among governments and donors, which aims to develop and support institutional coordinating mechanisms.

In the recent Worldwatch Institute publication, **Reversing Africa's Decline**, the problem of land degradation is identified as spelling the difference between agricultural development in Asia and Africa(Brown and Wolfe, 1985):

> "Restoring the productivity of African soils will require a different approach than the Green Revolution in Asia. The restoration of land productivity in Africa depends on restraining cultivation on marginal and steep lands and on making the most suitable land more productive. In contrast to Asia, where the overriding goal was to combine abundant water and artificial fertilizers to raise crop yields, the immediate target in Africa must be to restore vegetation and soils to make the most of limited water supplies. Africa's own green transformation will depend on breaking the cycle of land degradation. If soils are secured and vegetation is restored, crop yields will begin to rise toward their potential. (p. 45)

Beyond the return of soils to some measure of their productive potential, however, is the challenge posed by the need to increase both subsistence and commercial production above historical levels, and the parallel requirement of maintaining soil productivity at unprecedented levels of yield.

It seems evident that a much more prominent role must be played by soils science and soils management in all spheres of activity related to food and tree production in Africa.

1.8 Preliminary agenda of actions

This following tentative agenda will hopefully be modified, supplemented, and ultimately prioritized during the planning work over the coming months.

Map and describe Africa's agricultural soils at the 1:250,000 scale, with the aid of satellite imagery and aerial photographs, as well as ground surveys, with priority in the semi-arid, and sub-humid agroecological zones(90 to 270 day growing seasons) and the tropical highlands.

Interpret land capability at 1:250,000 for agricultural soils.

Map SSA's rangelands at 1:1,000,000 (or larger where justified)according to soil and moisture factors affecting productivity.

Develop international coordination for the development of locally produced phosphate fertilizers and set goals for research and development over next 10 years.

Expand research on use of leguminous plants for managing soil nitrogen, in sub-humid as well as humid environments.

Undertake soils management research and development for different stages of soil degradation, in the major soils of the different sub-regions.

Expand the soil management component of national and international agricultural, range and forestry research in sub-Saharan Africa.

Evaluate and carry out applied research on the economic costs and benefits of soil erosion control and other productivity restoring techniques, for all major soils, beginning with those in present AID projects.

Develop simple techniques for monitoring soil loss and productivity declines for different soils, that can be used by rural agricultural extension personnel.

<u>Existing AID projects which could be vehicles</u>

Soil Management Support Service

various agricultural research projects

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2.0 Loss of Vegetative Cover and Productivity

2.1 Forests and range resources

The woody vegetation in Africa occupies 44% (1,313.580 million ha.) of the total woodland resources of the world. It is comprised of(OTA, 1986):

Closed forests (216.634 million ha.),

Open woodlands (468.445 million ha.),

Scrublands (442.74 million ha.),

Open woodland fallow (104.335 million ha.),

Closed forest fallow (61.646 million ha.)

Plantation forests (1.780 million ha.),

Rangelands are wild forage producing areas under native grasses used, among other things, for livestock, wildlife and watershed maintenance. In Sub-Saharan Africa they occupy an area of 1,945 million ha. (range and pasture)or about 65% of the total land area (WRI 1986).

The vegetative formations of Africa have been mapped and described by UNESCO(White, 19), but maps of present vegetative cover do not exist. FAO was in the process of preparing such maps in 1986, using satellite and aerial photographic imagery.

2.2 Forest Loss

Africa's forests have been reduced by a half in this century due to a combination of intensive population pressure, agricultural encroachment, poverty resulting in fuelwood dependency, excessive livestock numbers, and commercial logging (Clausen 1986). The natural forest resources of countries such as Ethiopia, Rwanda and Burundi have been almost totally depleted. In those countries still with forests , there are being cut at a faster rate than they are being replanted.

It is estimated that over the past 10 years, 1.3 million ha. of closed forests were cleared annually in Africa (WRI 1986). Another 2.3 million ha. of open woodland were also deforested each year in Africa between 1980 and 1985 (WRI 1986).

Deforestation adversely affects both agricultural productivity and the quality of life of both the rural and urban poor. It can lead to a 15-20% reduction in crop and livestock yields (Clausen 1986). About 50 million people face acute fuelwood scarcity and 5 million hectares of Africa's upland watersheds are deforested and in urgent need of rehabilitation (Clausen 1986). Soil erosion and disruption of stream flow are shortening the life of reservoirs.

Deforestation is a contributory cause of the desertification process that is affecting over half of the surface of sub-Saharan Africa. As described in the Africa Bureau Forestry and Fuelwood Strategy Paper (1985), "Deforestation and its accompanying desertification is eroding U.S. and other donor agricultural development assistance in sub-Saharan Africa on an accelerating scale....As many as 200 million people in Africa already live in fuelwood deficit areas and without remedial action, this number could rise to 535 million by the year 2000...."

Clearing of Africa's vast stock of closed humid forests is fastest on the West African coast, where only approximately 10% of the original forests remain. The rate of logging and export of timber from the Ivory Coast has been especially high. Logging in Zaire and adjacent humid equatorial states has been slow, however.

2.3 Rangeland degradation

Information on the condition of rangelands and pastures in Sub-Saharan Africa is scanty and inadequate for the derivation of realistic estimates of their productive potential or carrying capacity. Perennial woody trees and bushes are important components of the range resource.

Encroachment of the farming frontier into the more humid rangelands(traditionally important as dry season grazing reserves) have led to severe deterioration of range conditions by reducing the area available for grazing, and exposing the range to erosion. Frequent fires also take the toll of a significant portion of the grazing resources for want of adequate fire protection. Range is also degraded by trampling and compaction, causing rain to run off rather than seep into the soil. Species tolerant of drier conditions as well as fires proliferate.

This process of range xerification can lead ultimately to desertification. Actual deserts have formed in the vicinities of perennial watering points, which despite efforts at management of stock numbers have invariably attracted far too many animals than surrounding ranges can support.

2.4 Fuelwood as a limiting factor

In West Africa's drylands, the World Bank has calculated that fuelwood not food is the limiting factor on population; both have been exceeded -- fuelwood moreso than food -- in areas with rainfall less than 800 mm per year(9 out of 10 years)(World Bank, 1985). That line corresponds closely with the southern limit of the ASA sub-region as defined in this report. For instance in the most arid cereal growing zone (less than 350 mm), agriculture could support on average up to 7 people per square kilometer, but vegetative resources for fuelwood could supply only 1 person per square kilometer on a sustainable basis. The computation did not include demands for browse, which would decrease wood production by reducing leaf surface and therefore photosynthesis.

Food production capacity can increase in the future. But research to increase fuelwood production capacity has not yet been undertaken to a degree commensurate with the fuelwood crisis. ICRISAT scientists predict that millet and sorghum yields in the sub-region can be increased through research from an average of 630 kg/ha in 1975 to 940 kg/ha in 2000(Ryan and von Oppen, 1984, p. 59, Table 7). With elite cultivars, now existing for sorghum and improved practices doubling of yields in farmers fields should be possible by 2000.

On the other hand predictions of fuelwood availabilty all point to declines.

FAO has assessed and mapped the fuelwood situation of Africa(FAO, 1981). Nowhere in the arid and semi-arid zone of Africa is there enough fuelwood for present needs. There are such severe shortages of fuel in the Ethiopian highlands that the zone is labelled critical, being characterized by overcutting and a drop in fuelwood consumption. Other regions of acute shortage are north-central Nigeria, and south-central Burkina Faso. Only in thinly populated southeast Senegal are fuelwood resources sufficient for local population, however, charcoal production for the Dakar market had begun to make inroads on the woodlands of this zone.

Even in the adjacent sub-humid zone, there is a fuelwood deficit, in some nations, especially in Kenya, Ethiopia, and Angola, whose ASA fuelwood resources are being exhausted.

Perhaps, with great effort and as yet unforeseen technological advances, alternative sources of fuel and dry season fodder now supplied by native vegeetation could be developed. However the stability and resilience to normal as well as exceptional extremes of aridity provided by permanent vegetative cover cannot be foregone. Therein lies the urgency of several kinds of work with perennial vegetation in the subregion, namely:

* Management of natural vegetation(in forest and grazing reserves.

* Improvement and expansion of agroforestry species, configurations, etc.(systgems as an necessary ecological component of dry land farming.

* Genetic enhancement of superior tree and browse species and their management.

* Improvement and extension of biological means of fertility enhancement for perennial species(i.e. N-fixing organisms, mycorrhizae, etc.)

Complementary demand-reducing actions are needed:

* Further development and extension of fuel-conserving techniques for cooking and heating...the latter is needed during the nighttime and early morning at higher elevation ASA and during the so-called "cool dry season" throughout the ASA.

* Further development of more efficient techniques of charcoal production, exemplified by the "Casamance kiln", in order to lessen urban demand on fuelwood resources.

Ultimately, also groundwater may become a limiting factor along with fuelwood. However, knowledge of this resource and its renewability is insufficient to make predictions. An on-going study of groundwater in West Africa sponsored by the European Economic Community will help quantify this resource(see Annex B).

2.5 Responses in Africa

In Zambia where livestock numbers are 10 times the carrying capacity of the available rangelands, the range is rapidly deteriorating. Large areas of Zimbabwe's rangelands are also overgrazed or bare, including 4 million ha. of former trust lands (WRI 1986).

Range conditions in the drier northern parts of Cameroon are generally poorer than in the wetter, southern Guinean zones, where livestock numbers are limited by trypanosomiasis. In the north, heavy over-grazing, frequent fires and periodic droughts have caused annual grasses, unpalatable shrubs or bare ground to replace the original perennial grasses and leguminous trees (WRI 1986).

few countries have made important progress in reversing deforestation, offering an example to the continent. They include Rwanda and Malawi, where planting over individual farms has reached a level where some experts believe the deforestation problems may be well or their way to being solved.

The scale of tree planting in many parts of Kenya is commendable. With modest beginnings in early 1970's, tree planting, along with soil conservation, through a strong initiative of the present government, has reached the proportions of a national crusade. The success of tree has primarily been the result of a strong leadership and political commitment, backed up by resources, engagement of the populace, and a real shift in spending priorities.

Semi-arid zone forestation and vegetation management has been hampered by the drought that has endured since 1968, as well as initial mis-appreciation of the productivity, ecological role and uses of trees and other perennial vegetation. Much has been learned in the past 10 to 15 years, as project results have come under the scrutiny of evaluations by AID, the World Bank, FAO and others(Weber, 1985; AID, 1984, World Bank, 1985). The process whereby forestry actions are identified and planned emerges as an important pre-condition of success.

Planners have often misunderstood the logic of traditional production systems and the role of trees and other woody vegetgation in them, whether in natural formations or around fields and farms.

Lack of participation by ostensible beneficiaries has been a common weakness of forestry projects. Supposed beneficiaries usually have little input in the planning process, and project design suffers in consequence, nor are their views regularly solicited and acted upon during implementation.

Another contributing cause has been the underestimation of a) managerial weaknesses of the existing institutions and/or the difficulty of setting up new ones and b) the remaining strengths of local institutions.

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Development assistance for addressing the policy issues, institutional development or restructuring has been limited. Donor assistance has not, in general, taken due cognizance of the absorptive capacity of the national governments into account.

2.6 Development assistance responses

Development assistance in forestry has focussed in the recent past on the use of trees to combat desertification, forestation at different scales to resolve the fuelwood crisis that afflicts the semi-arid and sub-humid nations, and industrial forestry assistance in the more humid nations.

FAO's Tropical Forestry Action Plan, developed by Committee on Forest Development in the Tropics suggests action proposals for five priority areas and estimates investment requirements:

1) Forestry in Land Use,

2. Forest-based industrial development,

3) Fuelwood and energy,

4) Conservation of tropical forest ecosystems, and

5. Institutions.

According to this plan, five-year (1987-91) investment requirements for Africa are estimated to be over $1 billion.

The World Bank has supported the preparation by the World Resdources Institute of WRI's Tropical Forests Call for Action. Fourof activity were proposed : 1) Fuelwood and agro-forestry, 2) Land use on upland watersheds, 3) Industrial forestry, and 4) Ecosystems conservation. The plan also identified investment needs for each country in each of these areas. The estimates for Africa were

Fuelwood and agro-forestry	$507 million
Land use on upland watersheds	$191 million
Industrial forestry	$210 million
Ecosystem conservation	$130 million

Agrofroestry research needs have recently been reviewed. The International Union of forestry Research Organizations meeting met recently (January 1986) in Nairobi for that purpose. Participants stressed the need for greater cooperation among African countries in the field of research, prioritizing a) natural regeneration in silvipastoral systems, b) genetic improvement of multipurpose trees, and c) agro-forestry research. Training, extension and data dissemination networks were strongly supported.

UNSO's Greenbelt Restocking project in Western Sudan, in coordination with WFP and UNDP, has successfully completed its first phase and is entering into a second phase, constitutes one of its noteworthy efforts.

U.S. Response:

In the past few years, the U.S. has played a significant role in natural resource development. Reforestation, more general tree planting, soil and water conservation and integration of agriculture and forestry have been important themes.

An increasing amount of forestry activities are being financed through the P.L. 480 program: $36 million in 1982 compared to only $6 million in bilateral forestry projects.

AID is backing away from large plantations and supporting small, village scale forestation efforts, agro-forestry research and activities, and other small scale works. AID has developed partnership arrangements with the U.S. Peace Corps as well as several Private Voluntary Organizations -- CARE and Catholic Relief Services, as a means of expanding assistanced in forestry. Specific projects are listed in Annex A, and in the sub-regional descriptions.

An important complement to forestry activities is fuel conservation. AID is supporting or has recently supported directly or through PVO's and Peace Corps volunteers the development and diffusion of wood conserving stoves.

2.7 Preliminary agenda

Multidonor forestry sector reviews accomplished to date or scheduled for 1986 and 1987 in Africa(see Annex B, under FAO), will diagnose in detail the needs of individual countries.

Several actions can be proposed at this point, however.

* Institutional strengthening and support

* Additional support for NGO's engged in activities directly or indirectly helping to amerliorate the various problems and causes of vegtative degradation.

* Support for vegetation surveys and inventories

* Assistance in policy analysis and modification

* Support for protection and management of forests and range in the protected category.

* Extension of fuelwood conservation and production

* Support to agroforestation activities.

* Support to watershed rehabilitation and conservation

* Support for rangeland rehabilitation and management

* Support for research

In the sub-regional treatments, more detailed recommendations for these various categories are set forth.

3.0 Water resources

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* * * * * * *

The AID Planning Committee identified degradation of ground and surface waters due to pollution and salinity build-up as the management issue affecting water resources.

This review of sub-Saharan Africa's water resources found, in addition, a multiplicity of present and foreseeable management problems. Besides pollution problems, which are rather spotty and poorly documented, there are problems of water related di?seases associated with irrigation development, dilapidated irrigation schemes, weak or total absence of water management once development takes place, and weak planning of water and related land development, notwithstanding efforts by international organizations, including AID, to build institutional and technical capacities for water resources development.

The exceptions to this panorama are the many fairly well functioning electrical generating authorities, a few well functioning large scale irrigation schemes(e.g. Madagascar), and countless small irrigation projects that are evolving with international assistance along major rivers and in swamps or seasonally flooded depressions.

3.1 Background

USAID has not financed a major African Dam since the Akosombo Dam on the Volta River and since 19 has not been mandated to build dams. But AID can and has assisted water resources development through projects that strengthen development authorities, survey and plan irrigation projects, assess or research groundwater, rivers and lakes, and assess environmental impacts of river basin development.

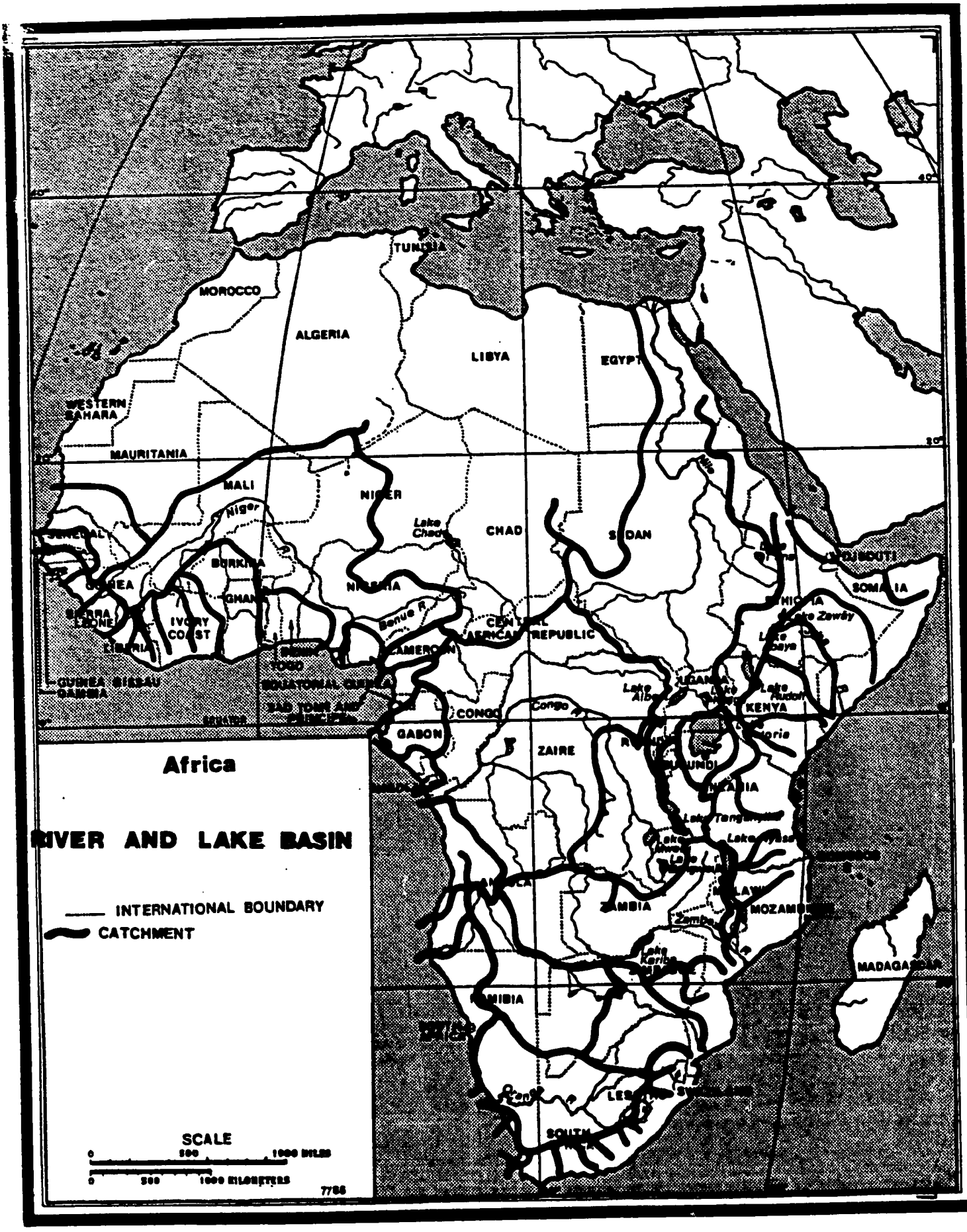
The historical background of water resources development in Africa is one of numerous, post-WW II large dams, irrigation projects and stock-watering boreholes that have generated high financial, environmental, and other social costs. The environmental backdrop is one of deforested and eroding upper watersheds, many rivers with regimes affected by the below normal rains and drought of the past 18 years, and a general lack of long term meterorological and hydrological records as well as knowledge of sub-surface geology needed for assessment and design. Large dam and irrigation projects in particular have been plagued with a wide spectrum of social and environmental problems.

Large dams and irrigation systems in particular have been sharply criticized(Goldsmith and Hilyard, 1985). The cumulative effect of damming up African rivers on estuarine productivity is an unknown and as yet unstudied impact. The effect of the drought on West African estuaries is indicative. It has reduced or stopped the flow of fresh water to estuaries in the Sine-Saloum and Casamance rivers, Senegal, and the Gambia river, Gambia, stressing mangroves and disrupting the breeding habitats of these water. Also the unique West Africa estuarine rice fields, planted only in the rainy season when the estuaries are sweetened by run-off were salinized.

3.2 Sub-Saharan Africa's water resources

Sub-Saharan Africa's surface waters are unique in comparison to other continents on several counts.

Most of Africa's rivers are shared by several nations. International rivers number 57 although there are only 15 main drainage systems in Africa (Figure).


Africa
RIVER AND LAKE BASIN
INTERNATIONAL BOUNDARY
CATCHMENT
SCALE
0 500 1000 MILES
0 500 1000 KILOMETERS
7786
TUNISIA
MOROCCO
ALGERIA
LIBYA
EGYPT
WESTERN SAHARA
MAURITANIA
MALI
NIGER
Niger
Lake Chad
CHAD
SUDAN
DJIBOUTI
SOMALIA
BURKINA
GUINEA
GHANA
NIGERIA
SIERRA LEONE
IVORY COAST
LIBERIA
Benue R.
CENTRAL AFRICAN REPUBLIC
CAMEROON
TOGO
EQUATORIAL GUINEA
SAO TOME AND PRINCIPE
GUINEA BISSAU
GAMBIA
Lake Zawdy
Lake Abaya
Lake Albert
Lake Rudolf
KENYA
Congo
CONGO
GABON
ZAIRE
BURUNDI
Lake Tanganyika
Lake Victoria
ZAMBIA
MOZAMBIQUE
Zambezi
Lake Kariba
MADAGASCAR
NAMIBIA
SOUTH

International cooperation is imperative for river basin development in the region. Today there exist multi-state river basin commissions in Africa, but these are generally weak institutions.

Secondly, the upper tributaries of most of Africa's rivers arise not in rain forests or cloud forests, as is the case in South America and Asia, but rather in sub-humid uplands with three or more dry months. Almost everywhere these uplands are populated, over cultivated, over grazed and subject to seasonal burning, resulting in sharply seasonal flows, and heavy sediment loads.

Flooding, wandering river channels, and in some rivers heavy sedimentation of reservoirs and irrigation feeder canals are the outcome of these natural and man-induced situations in the upper basins.

Third, irrigation potentials in semi-arid and arid subregions are restricted by relatively flat terrain with few appropriate damsites or gravity irrigation possibilities, a generally poor match between rivers and arid zones needing irrigation(the Nile being the exception), as well as meager groundwater resources.

Fourth, the vast inland deltas of a number of African rivers support not only fisherfolk, farmers and pastoralists, but also a diverse local fauna as well as over-wintering waterfowl from Europe. Their development can destroy irreplaceable habitats. Lastly, schistosomiasis has invariably accompanied impoundments and irrigation developments in Africa. Only the Cape Verde Islands are exempt. Waterweeds are a related problem affecting lakes and canals. Both problems are extremely troublesome, and difficult to manage, resulting in human suffering, weakness and loss of productivity.

Like soils and vegetative resources, water resources and aquatic environments are, with few exceptions, very poorly known, forlack of research and surveys on their limnology, productivity, fisheries, and related characteristics. The exceptions are some of the man-made lakes, e.g. L. Volta and L. Kariba.

Water development for irrigation.?

Irrigation experience and prospects in sub-Saharan Africa have recently been reviewed by FAO(FAO, 1985) and are summarized below.

Table 3.1

Present irrigation development in Sub-Saharan Africa

	Million Has.
Government-developed irrigation	2.2
Traditional irrigation(flood, swamp low lift and surface)	2.7
Modern, private sector	0.4
Total presently irrigated	5.3

Nigeria, Chad and Sudan have large surfaces of potentially irrigable soils, but other countries in the arid and semi-arid sub-region are not so well endowed. Also, the largest extent of potentially irrigable soils are not in arid and semi arid nations but in the sub-humid to humid ones,e.g. Angola(6.7 million ha), CAR(1.9 million ha), Mozambique(2.4 million ha),and Zaire(4.0 million ha).

Table 3.2 Present and potential irrigated surfaces in semi-arid and arid sub-Saharan Africa, 1985 (FAO, 1985).

	Irrigated	Irrigable
	'ooo ha.	
Botswana	12	100
Burkina Faso	29	350
Chad	46	1,200
Ethiopia	113	670
Gambia	26	72
Kenya	49	350
Mali	150	340
Mauritania	23	39
Niger	24	100
Nigeria	840	2,000
Senegal	187	180
Somalia	85	87
Sudan	1,700	3,300
Arid and semi-arid totals	3,284	8,788
All Sub-Saharan Africa	5,293	33,641

Small scale traditional irrigators number about 2.5 million families. On large public schemes approximately 850,000 small scale irrigators operate 60% of their surfaces.

FAO estimates that irrigated grain production in SSA represents only 10% of consumption. In 1982, 1.5 million tons of coarse grains (sorghum, etc.) were produced under traditional irrigation, and 3.7 million tons of rice were produced, of which 1.0 million tons were produced in Madagascar in wetlands.Only 1/6 of the region's total rice production came out of modern irrigation projects.

The costs of developing irrigation systems with surface water range from $3,000/ha for 10 to 50-ha village level schemes in Mauritania to $8,400/ha for large, public developments in Niger requiring land levelling. In Sahelian Africa, low yields and high production costs have undermined the economics of large schemes.

Irrigation development with groundwater is prohibitively expensive except for the highest value crops. In Mali, for example, development of a well yielding between 7 and 14 cubic meters per hour, and a small reservoir(100 cubic meters), and related fields would entail the following costs, varying according to the power source (FAO, 1985, Annex I):

Table 3.3. Costs of irrigation with groundwater in Mali.

Energy source for pumping	US$ per hectare
Diesel	15,400
Animal	19,200
Solar	34,500

Traditional irrigation from shallow wells is cheap but very labor intensive. In Chad, for instance 1/4 hectare of irrigated wheat or corn requires that a farmer pump a total of 50 to 60 days, seven hours a day, using the counter-weighted chaduf.This effort is only tolerable if the water table is shallow, i.e. 3.5 meters or less(ORT, 1986). PVO's and donors are active in assisting small traditional irrigators to find ways to pump more water and increase production(better pumps, seeds, fertilizers, credit, etc.), however management of water consumption, water quality and sometimes of pesticides usage remain troublesome technical aspects of these small, "low technology" schemes.

Lake resources and their management

Man made lakes are not included in this discussion. Presently AID is not participating in dam construction or man made lake management in Africa. Most man made lakes are ten or more years old and have developed fisheries management programs with assistance from FAO.

Africa's lakes are important for their fishes and aquatic wildlife, as well as their water resources. Africa has many important saline lakes as well as fresh lakes.

Saline lakes attract spectacular birds, as at the Nakuru and Arusha National Parks. There are approximately 50 such lakes, mostly in East Africa. Lake Nakuru is receiving a stead inflow of industrial and agricultural pollutants, but the impacts are not known(Symoens,et al, 1981). Shallow lakes in Zimbabwe are also experiencing pollution. These lakes are more sensitive to eutrophication than deep lakes, and more sensitive to development such as canalization, due to their shallow morphology.

Numerous shallow lakes have formed within closed drainage basins, such as Lake Chad. These are characterized by marked seasonal or long term changes in water level and salinity. This characteristic jeapordized a World Bank polder project in the Lake Chad basin, whose works were almost irreparably damaged by unexpectedly high lake levels in 198 . The salinity levels and high turbidity in these closed lakes have one very positive effect. They curtail the incidence of schistosomiasis, whose snail hosts and free swimming cercariae don't tolerate these conditions.

Shallow lakes can be productive fisheries although ones that are susceptible to lake level changes. In Lake Chad fisheries harvests ranges around 100,000 tons/year during 1974 to 1980(p. 170), contributing importantly to the protein requirements of the populace(average of 22 kg/person/year). Spirulina, an edible alga, is also gathered from the lake's shallow waters.

Deep lakes in Africa are also concentrated in East Africa in the Great Rift valley: e.g. lakes Tanganyika(over 900 meters deep), Kivu, Malawi, Victoria, Turkana and Edward. Water temperature and related characteristics below the surface of these lakes display a stable gradient, or stratification. Absence of oxygen at depths results in the production of methane, from anerobic decomosition of organic matter, which is tapped in some places, e.g. Lake , in Rwanda.

Africa's deep lakes are showing the effects of overfishing, namely a reduction in fish size, especially since the introduction of the nylon gill net in the 1950's. Fishing is traditional or artesanal, and not easily controlled. In Lake Victoria the dangers of exotic introductions are exemplified. The carnivorous nile perch(?Lates nilotica?) was introduced in 1960 and has virtually eliminated the once productive cichlid fisheries of the lake. Introduced ?Tilapia? have partially compensated this loss. Pollution is also affecting deep lakes, whose shores have long been settled. Pesticides pollution is of greatest concern. In Lake Tanganyika DDT metabolites have been found in fish at concentrations of 0.45 to 2.3 mg/kg in sun dried fish. 10,000 hectares of lakeshore cotton fields were receiving 45 tons per year of DDT in aerial spraying(Symoens et al, 1981,p. 123). DDT metabolites have also turned up in dried fish flour from fish caught in Burundi(ibid,p. 154).

Metabolites of chemicals used to control insect vectors of river blindness and sleeping sickness have been found in fish and birds such as king fishers in the Lake Chad and Lake Victoria basins.

In general,however, deep lake pollution is not being well researched or monitored, owing to the sophisticated analytical and sampling techniques that are only recently being acquired.

3.3 Issues in water development: Sudan as a case study

Sudan's dams and irrigation projects have suffered virtually every environmental, social and related economic problem that can be associated with water development in Africa.

Siltation of reservoirs and irrigation canals is a major concern of irrigation projects in Sudan(El BAdri Ali, 1983), whose rivers arise in the rapidly eroding Ethiopian highlands. (Rivers elsewhere in Africa carry less sedimient.) Silt has shortened the useful life of reservoirs (usually measured in centuries) and clogged irrigation canals, feeding weeds -- which further slow water flow -- rather than crops. Weeds also provide habitat for mosquito and snail vectors of malaria and schistosomiasis.

The recently completed Khashm el Birba reservoir on the Atbara River near the Ethiopian border had lost one half its capacity by 1982, only six years after closing. The Roseires Dam on the Blue Nile had lost almost one third its capacity by 1981, equivalent to 40 per cent of the production potential of the irrigated project that it supplies.

There are no engineering solutions to dam siltation, when rivers carry such high loads of sediments as those flowing into Sudan from Ethiopia. Additional siltation in existing reservoirs might be reduced by flushing but silt already deposited in the reservoirs cannot be economically removed. Sudan has considered upstream dams whose sole function would be as sediment traps, however these, too, would eventually fill.

Clearly, reduction of sediment loads through soil and water conservation measures in the Ethiopian catchments of the tributaries feeding Sudan's dams are the only solution. They would serve, furthermore, the dual purpose of rendering Ethiopian hillside agriculture and Sudan's irrigated agriculture more sustainable. Such work will involve international cooperation on a plane that is difficult to envision a present, but that must someday be achieved.

Sudan's vast Gezira scheme begun in 1920 has displayed virtually every possible difficulty and problem besetting state-owned schemes. Weed infestation of the canals feeding the 900,000-ha Gezira are a major factor in recent declines in productivity, caused by reduced water supply. Twenty-three species of weeds have been recorded in the canal system.

The weed choked canals have become breeding grounds for the snail intemediate host of Schistosomiasis. 60-70 % of the population in the scheme was infested by Schistosomiasis mansoni in 1979; in absolute numbers nearly 1.4 million people were affected(Goldsmith and Hilyard, 1984).The Ministry of Irrigation employs a large permanent staff to periodically dredge canals and remove weeds, but the problem persists. Chemical control is being introduced despite fears of pollution and environmental hazards (el Badri Ali, 1983).

Malaria infection rates are also high in Sudan's irrigation schemes, and what was once a seasonal problem in few places has become the number one killer in Sudan. Mosquito vector control has been complicated by progressive resistance of the A. arabensis vector to DDT and malathion. Tenitrothion(BNH) was being used in the early 1980's to control them(Abu Ahmed, 1983).

Agricultural pest control has put additional pressure on the mosquitos to develop pesticide resistance. Pesticides have been applied in Gezira in very heavy doses to protect the cotton crop, a major foreign exchange earner for Sudan. Other environmental and human health impacts of pesticides aren't available.

To combat these water-related disease epidemics, Sudan has set up an emergency treatment, research, and surveillance program, titled the Blue Nile Health Project. AID is supporting the Project with a ten year(1981-91), $8.48 million effort of schistosomiasis suveillance and control.

The schemes' tenant farmers have faired poorly, both from the standpoint of their overall health and their income levels. The Rahad extension of the Gezira project was found by USAID to have left the "beneficiary populations" worse off than before the project(Harrison, 1986

3.4 Development Assistance Responses.

Assistance by the USAID and other international donors to resolve the great range of management problems that beset the region's water resources has taken many forms. In general, water resource development per se has been hanmpered by lack of fundamental knowledge of the resources, narrowly defined policies, and fledgling or ineffective water and land development institutions, i.e. a situation of underdevelopment.

Indirectly, the drought has fostered small scale garden irrigation, associated with the emergency development of groundwater for community water supplies(well deepening and development). These have proven in many cases to be an essential ingredient to successful, small scale nurseries and dry season gardens. In fact, drought rehabilitation as well as emergency work at the community level almost invariably begins with water well development, first for people and domestic livestock, and then for nurseries and dry season gardens.

USAID

AID has focussed in recent years almost exclusively on the water development needs of drought-stricken nations, described below. In general, AID missions have not tackled water pollution as a development problem, unless it is related to rural potable water supplies. However, an isolated but successful activity to attack deep lake pollution has recently been supported by a regional project(Environmental Training and Management in Africa or ETMA).

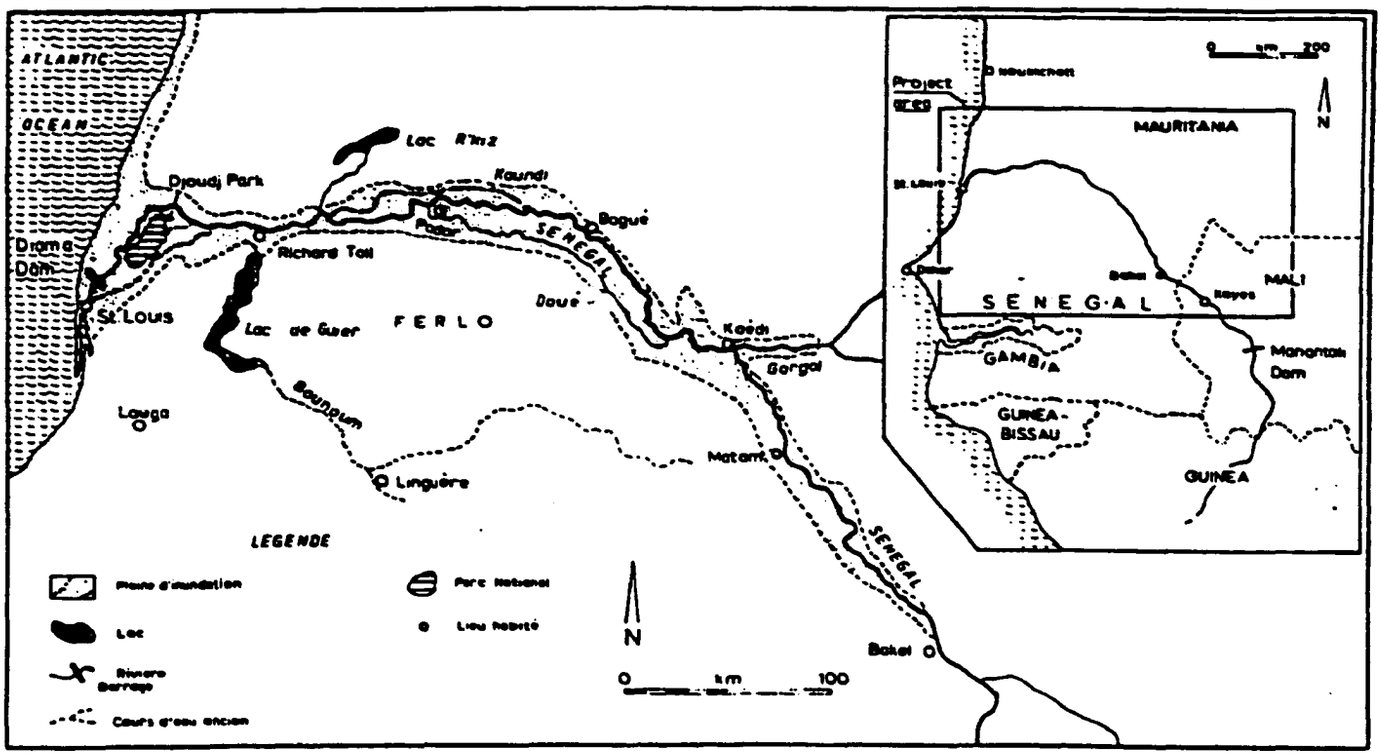
In Kenya, the Lake Basin Development Authority at Kisumu, on Lake Victoria was assisted by ETMA to construct and equip a water quality laboratory, by means of a 3-year series of consultancies and baseline studies of Winan Gulf ecology and water quality, as a sub-project of the ETMA project, during 1983-86. This assistance was in response to the growing threat to Winan Gulf and its fisheries resource from industrial, agricultural and urban wastes.

An S&T service project has been set up to help improve irrigation water management -- Water Management Synthesis -- and is now in its second stage. Very little work has been carried out in Africa to date, however, and have been largely as short TDY's fo design and irrigation sector assessments. The extension of this service project scheduled for design in 1986, will focus on Africa and Latin America, since the Near East and Asia Bureau will not be included. In the extension, Niger, Senegal, Rwanda and Burundi would be visited by multi-disciplinary teams to visit sites per-selected by missions and host country technicians to reconnoiter water resources development.

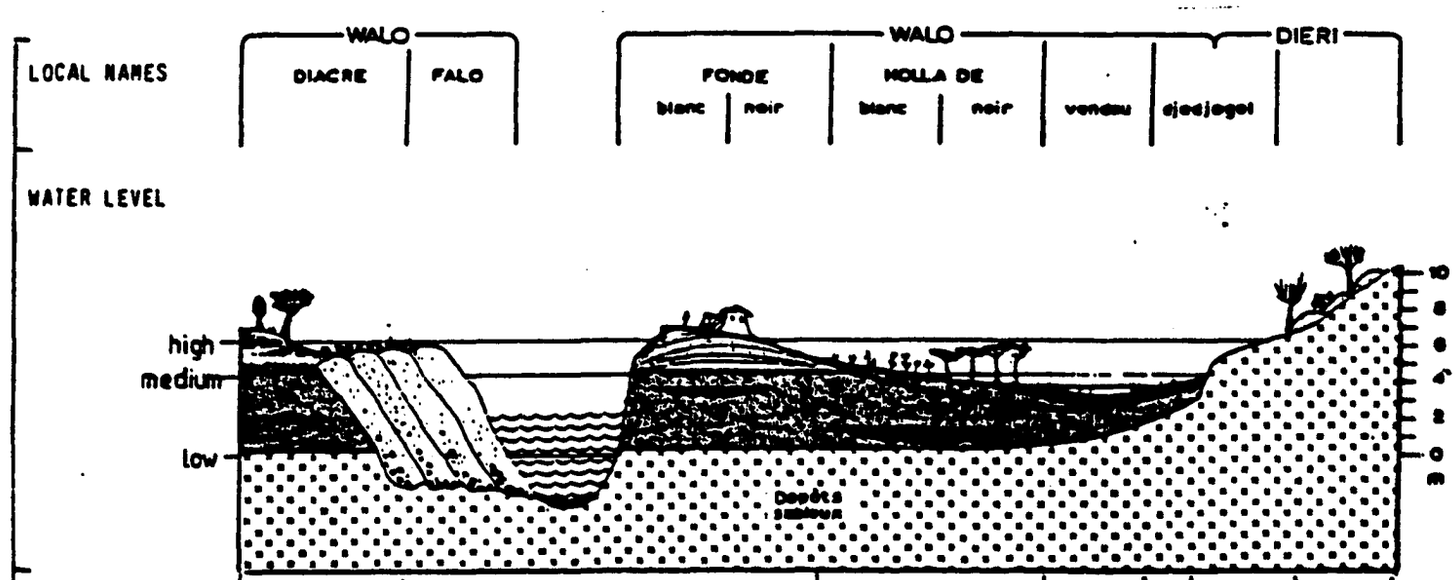
USAID's attempts to assist international river basin development institutions have been filled with setbacks and frustrations. however, small technical advances are being made. In April, 1985, AID sponsored a workshop on river basin development in AFrica in which experiences, issues, and problems were brought out(Clark U. and Institute for Develoment Anthropology, 1985). These are summarized later in this section.

In the Senegal River Basin USAID funded a $3.0 million environmental assessment of the UNDP Master Plan for the Basin, in the late 1970's. Subsequently, in 1981, USAID/Senegal began planning for a $60 million package of institution building and irrigation development, with related research, health and water quality monitoring to be carried out through the multinational Senegal Basin Development Authority, the OMVS.

Disagreement among the riparian states, Mali, Mauritania and Senegal, design problems, and changing priorities in USAID Washington delayed the approval of this ambitious project. Presently this "intgegrated" project initiative has been reduced to three separate projects, having little connectedness: (1)long term institutional planning assistance effort to the OMVS, funded at a level of $6.0 million over a five year period(1986-91).(2) a $4.6 million, 6-year project to establish a groundwater monitoring system in the Senegal River Basin responding to concerns that damming and water use will affect groundwater and require information for its management(the project could cost $3.0 million more than originally budgetted), and lastly (3) a 6-year project to support agricultural research in each of three riparian nations until 1990, each nation receiving approximately $1.0 million over the period.



The middle valley of the Senegal river.



	WALO			WALO				DIERI
LOCAL NAMES	DIACRE	FALO		FONDE blanc	FONDE noir	HOLLA DE blanc / HOLLA DE noir	vendou	djodjogol
GEOMORPHOLOGY	ancient levées	river bed deposition	river bed erosion	high deltaic levées	clayey depressions (sed., lagoon)		terrace nouakchottien	red fixed dunes
SOILS	sandy/clayey	sandy		fine sandy	clayey	very clayey	sandy	very sandy
VEGETATION	dry riverine forest			shrubs and marginal forest	Acacia nilotica forest (forêt de Gonakiés) and Vetiveria grasslands			dry forest
HABITATION AND TRAD. AGRICULT.		vegetables cereals		villages	recession culture (Sorghum)			villages

Cross section of the Senegal Valley.

USAID also sought to strengthen the multi-state Niger Basin Authority with a $11.7 million institution building project during 1982-86(Niger River Basin Planning, #625-0944) A later addition was by a $1.0 million project undertaken by the U.S. Army Corps of Engineers that was to make detailed morphological and sediment investigations of the Niger River, construct and computerize a model of the river's sedimentation patterns, and develop this as a planning tool. However, the effort is being terminated early for lack of a contribution to counterpart funding and personnel by the riparian states , a required condition for the utility of the results, and the project's implementation.

USAID recently commissioned a review of irrigation in Africa through the above-mentioned Water Management Synthesis project(Moris and Thom, 1985), " to examine whether wider adoption of irrigation could relieve existing food production constraints, either by stabi lizing food supplies in the drought affected zone or by permitting other farmers to use fertilizers and higher yielding varieties."

Traditional, small scale projects but not large scale modern systems were found to hold potential for increasing food production. Some other findings related to future actions were are listed in the final section.

Groundwater development experience by AID has not been reviewed except in the context of individual projects. Lack of expertise in hydrology and geohydrology in particular indicates a long term participant training opportunity. Numerous PVO's supported by AID are assisting villages accross Sahelian Africa to develop or rehabilitate wells for potable water and stock water. There is essentially no management component in this work.Use of Chadufs in Chad and Sudan to irrigate dry season crops is being supported indirectly by AID and others. Salinization problems are perhaps inevitable, but beyond AID control at the moment.

Training is virtually an automatic add-on to AID water development projects, but its impacts aren't evaluated nor do the long term students return in time to participate in the project that financed their scholarships. Rather than have training linked to development projects which "discover" a lack of trained personnel, training needs for water resources development and management should be assessed from the standpoint of long term trends, master plans for water development and related institutional and survey needs.

AID has in recent years supported aquaculture, rather than natural fisheries development.(Needs expansion including role of Peace Corps volunteers)

Other donors

The building of hydrological data networks has been largely supported by UNDP. However, a multidonor effort in the Sahel is sponsoring the regional AGRYHMET(agrometeorological and hydrological)network. AID is contributing $7.0 million to this effort during 1982-87.

UNDP and bilateral donors alike have financed the preparation of national master plans for water development, as well as national level groundwater surveys.

The EDF is financing a new survey of groundwater resources in West Africa.

The World Bank was preparing a proposal to up-grade hydrological and meteorological forecasting services throughout Africa, by using NOAA satellites, and improving data collection as well as extension services. Funding through UNDP was planned.

As regards river basin development assistance, the multi-donor funding arrangements typical of these schemes add to their complexity. Additional, and unfortunate, obstacles in the recent past to international river basin development have been civil strife(Chad, Sudan, Ethiopia, Uganda) and the long drought.

AID's participation in these schemes is noted above.

Disenchantment among international donors with large scale water development is widespread, even though African states see such development as the one sure way to satisfy expanding urban food needs, as well as insure food production from drought. To date, however, large schemes have been devoted to cotton for export, or sugar and rice for urban consumers, even during the prolonged drought that began in the Sahel in 1968. Also, the production costs of rice on large schemes is high. On SAED lands in Senegal, it was higher than the market price of broken rice imported from Thailand.

FAO's recent assessment of irrigation in the region agrees with the AID overview study of irrigation in Africa that the greatest potentials for assistance lie in the improvment of small scale, traditonal irrigation. This is an important change in emphasis from earlier large scale schemes.

Most international support for fisheries developments have focussed on off-shore fisheries or those in man-made lakes. UNDP support for Zaire's freshwater fisheries is an exception.

3.5 Considerations for an agenda of assistance

More effective and better managed development of water resources in support of agriculture is unquestionably needed in Africa. The technical potentials of irrigated agriculture are great, and have to some extent been realized by traditional irrigators.

The trend towards working at the small scale, with low input resources, and in direct assistance to traditional farmers is a realistic and understandable reaction to the ineffectiveness of large para-statals and ministerial services. However,as in the case of soils and vegetative resources, fundamental surveys and where needed research must be done to lay down the basis for reasoned actions that will sustain development, and not undercut its resource base. Assistance to building institutions and people in Africa that can manage the complex range of water resource problems should be a long range assistance objective.

Water resources development

The **African irrigation overview: summary** made the following recommendations regarding future AID development in irrigation (Moris and Thom, 1985):

* Institutionalization and rehabilitation of irrigation systems are more important than new irrigation. A joint World Bank/USAID effort was suggested. Research on the reasons for poor maintenance should precede financing of rehabilitation.

* Farming system research projects should include irrigation.

* Modest support for strengthening river basin development authorities is justified. They are the only authorities capable of planning and executing irrigation development. (Specific ideas are listed below, originating in a separate conference.)

* Continue U.S. work on agricultural applications of LANDSAT(where U.S. has a comparative advantage).

* Foster exchanges of technical information, especially on soil fertility maintenance, pests, and weeds in irrigation.

Regarding water related diseases, the overview indicates that UNEP in Nairobi offers "a possible base for expanded attention to this aspect of Africa irrigation". However, AID irrigation projects are obliged to review and if necessary control or prevent water related diseases, and this function should remain integral to AID-financed irrigation.

Nevertheless, if AID choses to support small scale, improved traditional schemes rather than larger scale schemes, through PVO's or other arrangements, management of water related diseases, salinization, weed problems, etc. could be neglected. A special technical assistance and management capacity, within AID/missions as well as host governments seems necessary to deal with these environmental and related social problems.

At an April, 1985, USAID-supported conference on river basin planning, Clark University and the Institute for Applied Anthropology identified the following kinds of support that AID could provide for river basin planning(Clark U., 1985, Chapter 2 "Overview"by Thayer Scudder):

* Institutional capacity studies to identify appropriate institutions to plan and implement African river basin development. Stress is laid on identifying existing local institutions, to balance exclusive assistance to the "increasingly ineffective" parastatal river basin development authorities.

* Increase efforts to improve the research, information dissemination and planning capabilities of existing agencies. (AID's insistence on a planning unit within the Niger Basin Authority, and the inability of the NBA to staff it, resulted in the above-mentioned phase-out of a river system study).

* Regarding large v. small scale projects, more attention is recommended to decentralizing management responsibilities within large projects(down to water user associations) and, on the other hand, to articulating small projects within a regional context so as to increase such potential multiplier effects as nonfarm employment.

* Integration of production systems from bottom to top, i.e. local production systems to regional credit and marketting organization to national policies and institutions, rather than from top to bottom, which experience has shown is always deleterious to local producers in and downstream from projects.

* Increased local participation in management of soils and water as well as forests, range, and wildlife, with more attention to maintenance of habitats and secondly to institutionalizing appropriate local organizations for protective, managerial and extractive purposes.

River and lake resources

A long term effort is needed in Africa to understand and monitor
the functioning of running and still water aquatic ecosystems, and their living resources, i.e. the biologial perspective on water resources. Without research and surveys, opportunities will be foregone and actions will be taken in ignorance.

AID could play a small but important role in training and research, and perhaps in additional support for aquaculture.

A recent UNEP sponsored symposium on Africa's inland waters, part
of which was summarized in the above discussion, recommended a number of actions concerned with inland water ecology and resour?
ces exploitation(Symoens and others, 1981).

In the area of limnology:

* increase number of African scientists trained in limnology.

* funding of studies of aquatic flora and fauna, and for publication of keys and manuals.

* launch an International Programme for Research on the Great Lakes and Rivers of Africa.

Regarding aquatic resources management:

* multipurpose uses should be sought for aquatic resources (fishe?
ries, tourism, recreation, etc.)

* to advance aquaculture, more limnological, physiological, and behavioural information needs to be collected on potential aquaculture organisms.

* rapid, general fisheries surveys are needed of rivers and lakes, especially those with flucuating water levels.

AID support for university training and research, in qualified African univesities(e.g. U. of Nairobi) as well as in the USA in the field of limnology should be considered.

AID could begin by supporting through existing manpower development programs a number of bachelor's level and graduate degree scholarships in limnology. Also worthy of consideration would be joint U.S./African research projects ?a la? now defunt MAB collaborative environmental research program in the late 1970's. Selected limnological and fisheries field surveys and research for various missions on a demand basis, provided through an arrangement such as the Environmental Planning and Management Cooperative Agreement with IIED should be considered.

The USA has a comparative advantage in training in basic and applied fields concerning water resources relative to, for example, training in tropical agriculture and soils, where we have little or no advantage. The need for training is outlined above. However, a major commitment in existing or future manpower development programs to water resources should be preceded by a survey of foreseeable needs for scientists and technicians throughout sub-Saharan Africa.

A number of existing or planned projects could become vehicles for AID activities related to water resources management:

OMVS agricultural research II(1984-90). #625 0957

Strengthening African Agricultural Research. #698 0435

Sahel Manpower Development II(1983-89). #625 0960

Sahel Manpower Development II(1986-90). #625 0972

Semi-arid Food Grains Research and Development II (1986-90) #698 0542

Environmental Planning and Management Cooperative Agreement between S&T/FENR and the International Institute for Environment and Development.

Extension to the Water Management Synthesis Project.

The current World Bank initiative to upgrade hydrological and meteorological services in Africa could be another vehicle for providing AID support to data management and institutional strengthening throughout Africa with minimal design and management effort.

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4.0 Coastal Resources Degradation

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The discussion of coastal resources focusses on the zone of transition betgween the ocean environment and the terrestrial or inland environment. There is a considerable variety in the definition of boundaries of the coastal zone, both to the seaward and the landward extremes, depending upon the research, survey or management objectives(Sorensen et al, 1984). In this document coastal resources are those found in estuaries, mangroves, lagoons, mudflats, beaches, and near shore continental shelf fisheries exploited by artesenal fisherfolk.

4.1 Fisheries and other coastal resources values

The fishes caught in African coastal waters are a particularly important component of the diet in the coastal waters of several countries (Ghana, Ivory Coast, Sierra Leona, Senegal, Togo), accounting for about 40 percent of the total intake of animal protein. In Congo, Angola and Mauritius fish constitutes 30 to 47 percent of the intake of animal protein WRI 1985). Per capita fish consumption in Comoros, Madagasacar, Mauritius and Seychelles is three to ten times that of neighboring East African mainland countries (UNEP 1982).

The annual fishery potential of African waters, both marine and inland, is substantial -- an estimated 11 million tons or about 15 percent of the current world catch. In the marine sector, most of the potential is located in northeast and southwest Africa (Table 8), where coastal state have low population densities. In the more densely populated regions around the Gulf of Guinea, and along the East African coast, resources potential is relatively moderate.

As the impacts of drought in West Africa persist, the coastal and marine fisheries resource have become even more important to coastal West African states, and are now viewed as a principal renewable protein resource, as well as of foreign earnings from exports of flatfish and crustaceans(shrimp, lobsters, prawns).

Coastal resources are important tourism attractions. Several of the East Africa island nations are heavily dependent on the tourist industry for foreign exchange earnings. It is the mainstay of the domestic economy of the Seychelles and the second greatest foreign exchange earner for Mauritius (100,000 tourists are attracted to its beaches annually) (UNEP 2982b).

In addition, coastal resources are important to other aspects of the inhabitants' livelihood. Mangrove forests provide both food, building materials and other products (ibid.). They are used locally and exported for firewood, building materials and tannin production. The mangrove swamps of Madagascar and Mozambique support very profitable prawn fisheries. Coastal reefs and beaches, in addition to their fisheries (ibid.), provide important sources of building material.

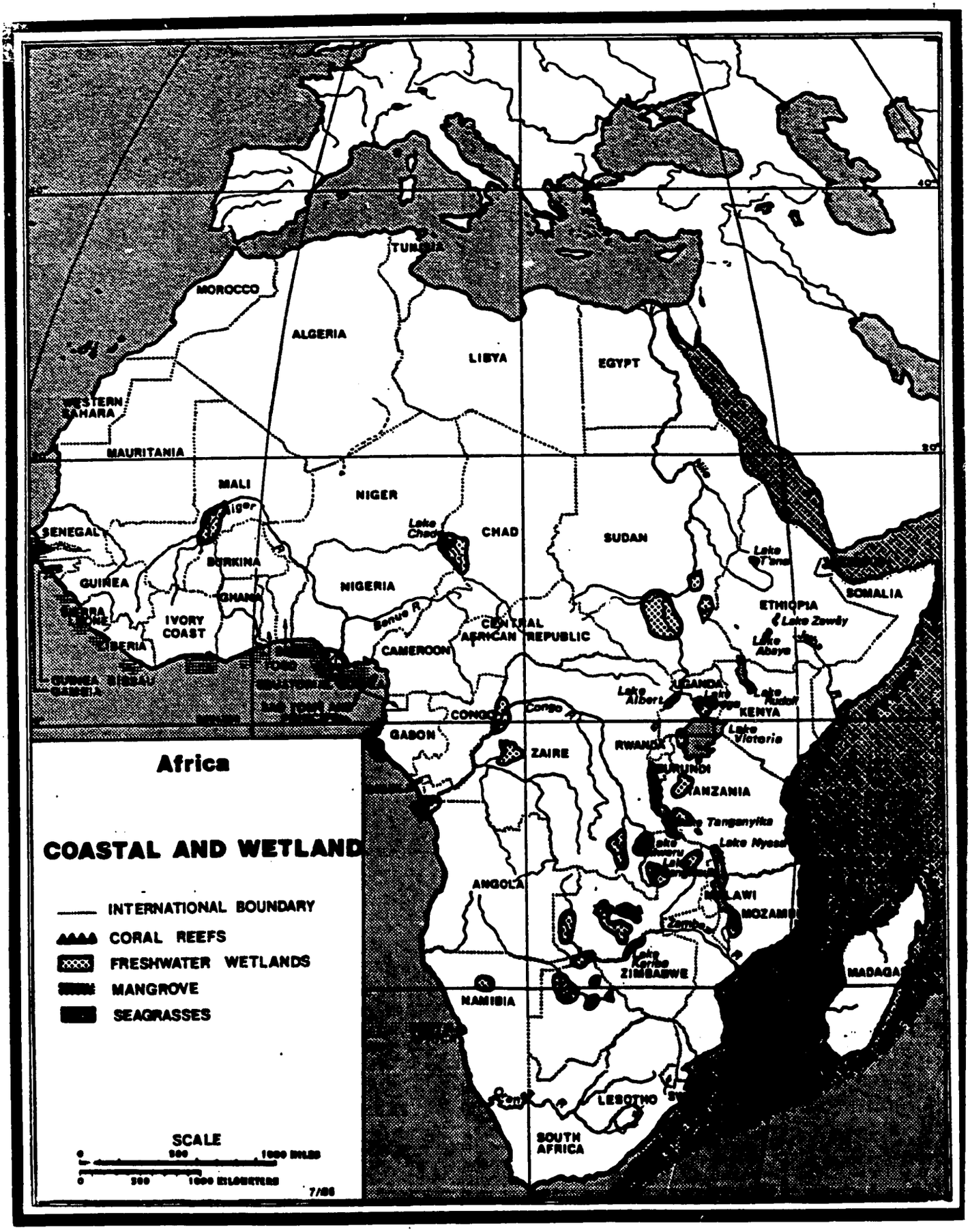
The demand for coastal resources is increasing. Over the last decade, the average annual marine catch for most countries has increased from 12% to as much as 525%, averaging 85% (WRI 1986).

The value of coastal resources are not limited to the confines of the nations which have them. They provide important habitat for many of the European waterfowl which winter along the coasts of Africa(ICUN 1985).

4.2 The role of estuaries, mangroves and coral reefs in the productivity of coastal environments

The mangroves of East, Southern and West Africa (700,000 hectares in the Niger delta alone)(WRI 1986 (Malthy 1986) provided habitat for over 2,000 species of fish, invertebrates and plants. As has been observed elsewhere in the world, mangroves serve as spawning and breeding habitats for estuarine species such as shrimps as well as some marine species. The effect of the deterioration of the mangrove forests can be sweeping insofar as it affects local fisheries and, more importantly, the lives of the people who are dependent on the fluvial/alluvial environment and the living conditions therein.

Estuaries and lagoons are equally important as well as being vulnerable to human impacts. They exemplify the


Africa
COASTAL AND WETLAND
INTERNATIONAL BOUNDARY
CORAL REEFS
FRESHWATER WETLANDS
MANGROVE
SEAGRASSES
SCALE
0 500 1000 MILES
0 500 1000 KILOMETERS
7/86
MOROCCO
ALGERIA
TUNISIA
LIBYA
EGYPT
WESTERN SAHARA
MAURITANIA
MALI
NIGER
CHAD
SUDAN
SENEGAL
GUINEA
BURKINA
GHANA
NIGERIA
IVORY COAST
LIBERIA
CAMEROON
CENTRAL AFRICAN REPUBLIC
ETHIOPIA
SOMALIA
GABON
ZAIRE
RWANDA
BURUNDI
TANZANIA
KENYA
UGANDA
ANGOLA
ZIMBABWE
NAMIBIA
LESOTHO
SOUTH AFRICA
Lake Chad
Lake Victoria
Lake Tanganyika
Lake Nyasa
Lake Abaya
Lake Zawiy
Congo
Zambezi
Niger
Benue R.

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interdependence of terrestrial and marine systems and are indispensable in the life cycles of many marine fishes and crustaceans and support valuable fisheries in themselves.

Coral reefs rank among the mnost biologically productive and diverse of all natural ecxosystems (Salm and Clark 1984). They support a high density of marine life and are widely dependened upon for their fisheries as well as medical and construction materials. Coral reefs and the associated white sand beaches support major tourist indistries. Reef deposits play a major role in Indian Ocean Island formation. Forty-seven percent of the total area of the Seychelles result from coral reef deposits (WRI 1986).

4.3 Degradation of coastal resources

Although the degradation of coastal and marine resources is very poorly documented, scattered reports from individual countries in East and West Africa point to a number of key problems. problems are occurring (UNEP 1982a). The problems can be broken into three areas:

Over-exploitation of fisheries primarily in West Africa, due to lack of regional and local regulations and/or lack of enforcement. Management of this resource is particularly difficult given the current inadequate knowledge regarding the biological nature and geographic extent of this resource, its seasonal distribution and migration through the waters of several nations, its ability to reproduce and withstand sustained and often totally unrestricted harvesting activities, and the lack of regional rules and regulations which couldact to conserve this essential resource(RDA 1985). Heavy fishing by unlicensed foreign fleets poses a serious threat to the continued existence of this resource, and has significantly altered the biological composition of fish stocks off the West African Coast over the last decade.

Loss of mangrove forests and estuaries in West, East and Southern Africa due to irrigation projects, damming of rivers and overcutting beyond sustainable levels(Malthy 1986). Losses have been aggravated by the impact of reduced freshwater inflows becasue of drought conditions. Mangrove areas have been subjected to clearcutting and conversion to areas suitable for salt and rice production. There are also indications that considerable illegal harvesting of mangrove occurs in the more inaccessible areas. (UNEP 1982a).

Although the development of domestic and agricultural water supplies has long had sectoral priority in development planning

in arid and semi-arid Africa, the need to implement various water development schemes appears to have been accelerated as a result of the drought. In this regard, the damming of rivers and the withdrawal of groundwater as is occurring in Senegal and Gambia pose serious threats to coastal marine environments particularly during periods of diminishing rainfall, runoff and groundwater recharge.

The reduction in freshwater runoff and the expansion of agricultural production is changing the basic nature of West African coastal estuaries and lagoons. Through a variety of mechanisms, it affects intertidal mangrove forests and estuarine and marine animal species that are dependent upon recurring temporal and special patterns of reduced salinity. (Berry 1986). Of major concern are potential irrigation development and water management projects, affecting the deltas of the Senegal and Gambia Rivers.

Destruction or Damage to Coral Reefs - Heavy use and misuse of the coral reef and its community appears to be increasing. The effects of over-fishing, blast-fishing with dynamite, and coral and shell-collecting have been reported from sites ranging the length of the East African reefs. Die-off of fish and coral due to high sediments loads and pollution have been recorded in Kenya, and Tanzania, respectively(UNEP 1982a. The losses could be attributed to the accumulative impacts of poor inland land use practices leading to high sediment loads as well as damming causing hydrologic flow changes.

The limited financial resources of coastal African nations (and donors) have been directed at terrestrial resources with more apparent, easily identifiable links with development. The complexity of the management problem deters effective responses, particularly to the accumulative effects of activities which cross national and international boundaries or occur several, if not hundreds, of miles away. Examples are in the likelihood that dam construction in Zambia will affect prawn production in Mozambique by changes in freshwater flows. A barrage and irrigation projects in Gambia adversely affecting European waterfowl which winter in the delta area.

Lack of good information inhibits diagnosis and planning for better mangement. For example, in East Africa where coral reefs play a major role in tourism, there are no quantitative figures on their abundance or critical area needs. UNEP (1982) has done a systematic review of the coastal resource issues of East Africa, discussing both the concerns and possible means to address them. Sorenson et al (1984) discusses the coastal resource concerns of Africa as part of a general global issues index. IUCN, with possible U.S. assistance, is attempting to

more clearly define the issue and develop an action agenda. AID is currently working with the Park Service to do a literature review of the state of knowledge for Coastal West Africa.

Finally, institutional jurisdiction of coastal resources is often unclear, falling in an undefined area between marine and inland waters management. In Senegal, for example, it is neither in the jurisdiction of the division dealing with forests and inland waters(Eaux et Forets)nor does it come under the marine fisheries sector.

The concern for coastal resources among African nations is increasing. At the first African Ministerial Conference on the Environment, held in Cairo in October of 1985, a committee on the seas was established to:

(i) facilitate implementation of the UNEP regional seas programmes for West, Central and Eastern Africa; and

(ii) design programmes for the protection of the marine environment.

Three countries in West Africa (Mali, Mauritania and Senegal) currently belong to the 1971 Convention on Wetlands of International Importance.

4.4 Donor response

Governments and donor groups have tended to focus on the improved exloication of coastal and marine resources, through improved fishing, fish processing and marketting; establishment of tourist centers, hotels, etc. ; and in a few instances, creation of tourist related coastal parks and protected areas.

France's overseas research arm, ORSTOM, has been engaged in several research, modeling and monitoring efforts in Francophone, West Africa. Various United Nation organization, most notably the UNEP Regional Seas program, have undertaken a series of workshops and studies to come to grips with this complex issue. Several sets of recommendations and action plans have resulted. However, the degree to which they have been implemented and their success is unclear (UNEP 1982a, 1982b, 1983).

USAID activities

Almost every coastal West African nation has requested U.S. assistance in coastal zone resources management . A recent report "West African Living Marine Resource Conservation and Management" was the result of an analysis aimed at structuring an appropriate U.S. response (RDA 1985). This report reviewed the existing situation and problems associated with marine fisheries management and conservation of the West African countries of Mauritania, Senegal, Gambia, Guinea-Bissau and Guinea. It identifies appropriate areas for U.S. economic and technical support in the overall area of marine fisheries resource management and conservation, and makes specific recommendations for action.

In addition, USAID has contributed to coastal resources knowledge in West Africa, particularly in reviews of the Niger and Gambia rivers' contribution to coastal production.

Direct management of African coastal resources for long-term production has been lacking although USAID has indirectly contributed through support for international publications, conferences and training sessions dealing with coastal management. This has included a review of several international coastal studies which may have application to African needs (Clark 1985).

4.5 Preliminary agenda

The conclusions reached by the UNEP (1982b) Regional Seas Program directed at East Africa, can also apply to the Subsaharan Africa Region as a whole. Their findings were:

> "Although a significant amount of coastal and marine zones have not received the attention they deserve and that therefore further work should be undertaken to fill the gaps in knowledge. The implementation of a comprehensive action plan for the protection and development of the marine and coastal environment of East Africa is expected to result in further work at national and regional levels, to improve, monitor and strengthen the conservation of coastal and marine resources."

Specific recommendations formulated by UNEP werfe grouped under (1) the management of essential ecological processes and (2) the conservation of genetic diversity.

(1)Essential ecological processes and life support systems

Recommendations (on a national level):

(a) Priority should be given to ensure that the principal management goal for estuaries, mangrove swamps and other coastal wetlands and shallows that are critical for fisheries is the maintenance of the ecological processes on which the fisheries depend.

(b) Particular attention should be given to the formulation of a coastal and marine national living resources conservation and management strategy aimed at protecting and maintaining the support systems of critical habitats (i.e. coastal dry forest, coastal dunes, coastal flood plains, fresh and brackish water marshes, mangrove forests, reef-back lagoons, sandy beaches, etc.) and regulating the use of genetically rich areas (fisheries ponds, marine mammal feeding grounds, turtle nesting areas, nursery grounds for shrimps, coral reefs, etc.).

On a regional level:

(a) Ecological and biological inventories of coastal and marine life-support systems and the assessment of ecosystem capabilities should be continued and expanded to provide detailed classification of these ecosystems and their living resources content.

(2)Genetic diversity (threatened/endangered species of flora and fauna, and habitats).

Recommendations (on a national level):

(a) Priority should be given to species that are endangered throughout their range and to species that are the sole representative of their family or genus.

(b) Unique ecosystems should be protected as a matter of priority.

(c) Additional protective measures should be accorded, where identified, to marine turtles and their critical habitats. Further surveys should be carried out to inventory stocks, movements and conservation measures.

Recommendations on a regional level:

(a) A regional network of selected marine parks, equivalent reserves and management areas should be created with a view to affording better protection to coastal and marine ecosystems which are of vital importance as renewable food and energy resources for the people.

(b) Regional co-operative measures should be encouraged. Co-operation on a regional scale for conservation of all marine mammals and other marine resources is highly desirable.

(c) The development of a comprehensive mapping of systems should be considered (mapping of critical coastal and marine habitats; highlighting potential conflict and compatibilities of living resources in the region).

(3)Supporting measures: conservation for development

Recommendations (on a national level):

(a) Additional efforts should be made to strengthen government agencies responsible for the conservation of living resources. Where such an agency is lacking, measures should be taken to either create one or use existing infrastructure and administrative facilities to undertake the necessary action.

(b) National seminars and workshops on environmental and living resources conservation and management should be regularly convened to bring in all levels of Government and the public.

(c) Institutions studying coastal marine ecosystems and species should be encouraged and strengthened, especially by providing them with adequate research grants, professional staff and access to world-wide information and data through, for instance, subscription to publications and magazines.

(d) Further comparative information and analyses are needed to determine the adequacy of existing national legislations and policies concerning living resources.

(e) Nations which have not adhered to the major global conventions dealing with the conservation and management of living resources should do so to ensure the conservation of those living resources that cannot be conserved by national legislation alone.

(f) Where Man and Biosphere National Committees have been established, they should be strengthened and be involved in the decision-making process affecting the conservation and management of ecosystems. Where such Committees have not been established, advice should be sought from UNESCO on the feasibility of expanding the Man and the Biosphere Programme network.

(g) Where appropriate, traditional methods of living resources management should be retained or revived. This is particularly important in rural and fishing communities as one of the best methods of ensuring a sustainable use of ecosystems and species.

Recommendations (on a regional level):

(a) Major efforts should be made in the region to promote environmental awareness and to highlight the need to develop integrated conservation plans to ensure sustainable use of coastal and marine resources.

(b) Particular attention should be given to the establishment of a central data bank on coastal and marine resources inventories, research, conservation, management and utilization to ensure easy access to and dissemination of the available information.

(c) Due to a pressing need for trained technicians and managers of marine national parks and reserves, a regional training programme should be formulated and implemented through the use of an existing national or regionally-oriented institution, at least in the short-term, and in the long-term, the creation of a specialized facility in this field to serve the region.

AID (and other donors) could consider the following additional actions.

* Strengthening of AID and other donor agencies' intersectoral planning to include both the assessment of and mitigation measures for maintenance of coastal and estuarine resources. This is particularly needed in agricultural development and sector resource management in the arid and semi-arid subregion.

* Work with national and international political bodies to define and develop coastal resource conservation strategies for West African coastal areas beginning with the delta areas of the Senegal, Gambia and, in East Africa, the Zambezi rivers.

* Improve the inventory and data base for coastal resources of the African coastal areas starting with those of the arid/semi-arid West African coastal countries, including Guinea Bissau. These areas are of highest international significance and face immediate risk. It is important to the development, management and for their long-term productivity.

* Strengthen institutional capabilities, policy and technical skills of coastal countries in coastal resource management particularly in the semi-arid/arid and Madagascar/I.O. subregions. This would include working with NGO/PVO groups for training programs and workshops.

* Work towards the concept of sustained management and multiple use to interlink environmental and developmental factors in respect to mangrove forests. Their value is multi-faceted, their risk of loss is high.

* Support applied research to fill in the general information gaps existing on coastal resource productivity and their susceptibility to development.

* Strengthen coastal protected area management particularly within Ramsar convention member countries and for areas of international significance (world heritage sites, etc.). The U.S. has a great deal of expertise in this field.

The table lists subregional and country priorities based on coastal resource issues and immediate needs facing the subregions and countries. The table displays the various categories of intervention (policy dialogue, institutional development, etc.) and at what point in the planning period programs need to be undertaken (immediate, medium and long term). Those subregions and countries which have immediate needs should be the primary focus of AID/other donor programs and activities.

Table __ Coastal Resources: Priority, Subregions, Countries and Categories Where AID Technical and Financial Support Would Be Most Effective

*** = Immediate
** = Medium Term
* = Long Term

Priority	Subregion	Key Country(s)	Pol. Dial.	Institution/ Training	Research/ Data Centers/Inventories	Coastal Prot. Area Management		Wld. H.Needs	NGO/PVO	Reg. Strat.	I.D. Plan
						Est/Mangrv.	C.R.				
1	Arid/Semi-Arid Coastal West Africa	Mauritania	*	**	**	***	N/A	*	**	***	***
		Gambia	*	**	**	**	N/A	*	*	***	***
		Senegal	*	**	**	***	N/A	*	*	***	***
		Guinea Bissau	**	***	**	***	N/A	**	**	*	***
2	Mad./ I.O. Is.	Madagascar	*	**	**	**	*	**	*	N/A	***
		Comoros	***	**	**	?	***	**	**	N/A	***
3	S.H.T. Uplands	Mozambique	**	***	***	**	N/A	*	*	***	**

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5.0 Decline in Biological Diversity and Ecological Resiliency

5.1 Background

The World Conservation Strategy affirms that the preservation of biologic and genetic diversity is both a matter of insurance and investment. Currently there are plant and animal products that, although not widely recognized or domesticated, provide for the immediate needs of many African populations for food, shelter and medical needs. This is particularly true among the poorest and most rural populations.

There are many species whose value to mankind is still to be discovered. These can prove critical to sustain and improve agricultural, forestry and fisheries production; to keep open future options as a buffer against environmental change; and as the raw material for much scientific and industrial innovation. For many the stewardship of the land is a philosophical committment.

Throughout Africa the dependency of the humans on the health and productivity of their surrounding undomesticated resources is apparant.

- In many African countries, bushmeat, including unmanaged fish and wildlife resources, provide a significant source of animal protein. In 11 African nations, it supplies more than 10% of annual protein intake. In two cases, it exceeds 25%. Among the rural poor, this figure is much higher. In Ghana, wildlife has been shown to comprise 31 - 44% of total animal protein intake (Prescott-Allen 1982).

- Natural sources are the main supplier of fuelwood which supplies 63% of energy needs for the African population (FAO 1985).

- Exploitation of unmanaged tropical forest species have provided major sources of foreign currency in six West and Central African countries. This is in addition to their local use for building materials (Prescott-Allen 1983).

- Wild plants and animals continue to meet a large portion of the local health needs of African populations. As much as 85% of traditional medicines are derived from plants. Wild plants have also contributed to western medical approaches as well. Some medicines, such as hydrocortisone and atropene, have become so familiar to us that their origins have been forgotten (ibid)..

- New plant and animal species and/or varieties are continuing to strengthen our domestic food sources. The National Academy of Science estimates at least 2,000 plant species have important, food, fuel or other properties presently warranting study (OTA, 1985). In addition to new species, international agricultural research centers are continually searching for and finding new domestic and wild strains of agricultural crops to improve productivity and resistance. In Africa, there are at least twelve countries which are highly likely to contribute new plant varieties important to improvement of basic crops such as sorghum and millet (Hawkes 1985).

More obscure are the broader and indirect links between biological diversity and the well-being of mankind. When dealing with ecological systems or micro climatic changes, cause and effect relationships are hard to quantify due to their complexity and our basic lack of understanding.

The question of significant becomes incalculable. For example, we have just begun to recognize how significant the role of birds and mammals are in seed and pollen transfer in tropical forests. In Ivory Coast, it was found that forest bats accounted for 98.2% of all seeds deposited on recolonized sites along the edge of a gallery forest studied (Maury-Lechon et. al. 1983). This becomes important when one considers that tropical forests products export account for over 17% of Ivory Coast's total export earnings and was much higher in the past before widespread devegetation occurred.

It is quite possible that wildlife will do more for revegetation of devegetated areas than plantations if allowed to. Certain domesticated crops, such as cocoa and mangoes, are pollinated primarily by wild insects such as midges, wild flies and wild bees (Prescott-Allen 1982).

5.2 Biological resources management problems

Simply stated, just when biological and genetic diversity has the greatest potential to benefit mankind, it is being placed in greatest jeopardy.. It is estimated that by the year 2000, 100% of Nigeria and Ivory Coast's tropical most forests will be lost. Guinea will have lost 33% (WRI 1986). Within the arid and semi-arid lands, there is a sense of urgency to survey local domestic and wild stands of millet, sorghum and pigeon peas to collect valuable varieties before they are lost. Our ability to maintain biologic and genetic diversity must be viewed as a great measure of our ability to maintain natural resource productivity.

Conservation and development has been viewed as being distinct rather than inter-related concepts. Parks and forests were "protected", the rest was "developed". Biologic and genetic diversity was equated to conservation thus "protected". It is easy to maintain this relationship as long as landbases and resource pressures allowed mutually exclusive activities of protection and development. In many respects, the on-going ecological and human crisis in Africa has accentuated the gap. Major concerns are:

- Over-emphasis on a few domestic plants and animals for food and wood production in Africa. As brought out in a recent Office of Technology Assessment (1985) report, "as we move towards the 21st century, we rely on fewer and fewer plants and animals. We ignore or have forgotten thousands of useful species that could broaden and balance our forest resources." It goes on to point out that "one factor limiting the development of native or other unconventional plants is an institutional bias against them. The major emphasis of plant research during the last 100 years has been directed at the dozen or so primary food crops - to the exlclusion of almost everything else."

- Failure to integrate conservation and development resulting in the loss of biologic diversity. Past development and conservation policies have created artificial barriers to the long-term maintenance of biological diversity. On the other hand, natural resource conservation programs have often focused on a wildlife and plant protection with little or no regard for human use patterns or how income generated from protected areas could be used to improve the living standards of surrounding human populations. As a result of both shortcomings, the list of species threatened. endangered or lost, continues to grow.

The environmental assessment process being employed by donor groups, such as USAID and the World Bank is meant, in part, to facilitate development within an environmental context. Success in its use has varied, depending on technical skills and attitudes of those implimenting the process. Proper application and foresight has and will prevent needless loss of biological and genetic diversity. It will be a primary means to design for the continuance of biological systems and their productivity and also for further understanding of the interrelationships of the fragile communities in Africa.

- Continued poaching and illegal trade in wildlife. Poaching continues to constitute the major short-term threat to many species of wildlife and plants in Africa. This has been due to:

  1. the proliferation of modern weapons in the hands of the local populace due to regional and national strife.

  2. economic decline in African nations with a corresponding decline in budget, programs, staff and equipment which can be allocated to conservation and parks management.

  3. a declining standard of living for the local populace making poaching for food or sale increasingly attractive.

  4. continued markets in several major countries for illegally obtained wildlife and plant products such as rhino horn and elephant ivory.

  Even though 18 Sub-Saharan African nations belong to the CITES treat dealing with trade in endangered species, shortages in staffing and budget has severely affected the curtailment of illegal trade (IUCN 1981). Support for CITES activities in Africa primarily come from private sources. Also there is a fundamental lack of baseline data to establish biologically sound harvest quotas for control of sales.

5.3 Current activities

The conservation of biological and genetic diversity is currently receiving a great deal of national and international attention. As with desertification, it cuts across a multitude of sectors and activities. This becomes apparent when looking

at the areas of priority environmental concern established at the 1985 African Ministerial Conference on the Environment recently held in Cairo. Although biological and genetic diversity is not specifically mentioned, it is intrinsic in each committee's terms of reference. Since it covers such a wide area of concern, it has been difficult to develop clear program direction, priorities, or sectoral responsibilities.

Although several international organizations have begun to try to better define the problem and propose specific steps that could be taken to address the issue. International funding to address the problem in Africa has been slow in forthcoming.

Some examples of approaches underway are:

- The World Resources Institute is currently implementing the Critical Ecosystems portion of the Tropical Forests Action Plan Project to assist 4 countries in Africa with declining forest resources: Botswana, Cameroon, Zaire and Madagascar. The purpose is to develop mechanisms to review and incorporate information on critical ecosystems in the early stages of project planning. This project is in addition to their Tropical Forest: A Call For Action (1985) and the World Resources 1986 publications, both of which helped to synthesize and focus attention regarding biological and genetic diversity.

- The World Wildlife Fund is developing a series of projects in Africa, supported by a matching grant from USAID to link conservation with local development activities; thereby relieving people pressures on critical parks and protected areas. This is in addition to their extensive conservation programs primarily in eastern and southern Africa.

- The Nature Conservancy is beginning to establish conservation data centers in Africa, starting in Rwanda, to develop local sources of information on biological diversity. This has been highly successful in Latin America.

- IUCN has established an information monitoring center at Cambridge to maintain up-to-date data dealing with biological and conservation issues by region and on a country specific basis. The most recent undertaking has been a systematic review of the protected areas and wetlands, their status, and their importance to biological diversity.

- The UNEP Regional Seas reports and studies have helped focus attention to biological and natural resource issues within the context of coastal and marine resources. While UNESCO's Man and the Biosphere Programme have been an international scientific cooperative approach dealing with people-environment interactions including biological and genetic diversity.

- Major undertakings by international organizations such as FAO, ICARDA and IBPGR have been directed at the inventory and conservation of both forest and crop genetic resources. These groups and others are currently working on systematic inventories of African nations to identify domestic and wild strains of crops indigenous to Africa, particularly sorghum and millet.

- FAO has been involved in both regional and country level activities related to wildlife and protected area management as well as marketing aspects of wildlands products. Emphasis is being re-directed away from traditional conservation/preservation projects towards those which tie into soci-economic and environmental benefits that support both local and national objectives.

Within Africa the consensus for biological and genetic diversity is strong. All African nations are members of international treaties and programs dealing with the topic area. The continued maintenance of parks, reserves and biosphere reserves displays a commitment on the part of African nations to this concept.

5.4 USAID response

A comprehensive review of current U.S. activities dealing with biological and genetic diversity can be found in Programs in Conserving Biological Diversity in Developing Countries, FY 1985; A Report to Congress on Implementation of Section 119 of the Foreign Assistance Act.

USAID has taken a lead in U.S. policy dialogue on the issue including the development of a U.S. Strategy on the Conservation Biological Diversity.

In Africa, USAID has focused on those aspects of biological and genetic diversity which are directly linked with development, primarily agricultural production. This includes crop related genetic research and agroforestry. The underlying assumption is that through increasing productivity on lands currently

under production less pressure will occur in wildlands and their biologic and genetic resources. USAID is also using the environmental assessment process as a tool to lessen the impact of development projects on native biological communities. For example, USAID has recently undertaken anenvironmental assessment of the impact of a port improvement project on, among other things, aquatic communities..

USAID programs dealing with the management of natural biologic systems in Africa have been modest. Programs in this area do not fit within current USAID country development stategies for various African countries nor do USAID missions feel that this is a priority area in comparison to more pressing social and economic issues. Another factor is where, within sector programs and funding, does management of natural systems fit.

In spite of this problem, USAID Africa has supported natural biologic systems conservation in the broader context of natural resource management, particularly watershed management, as in the case of the Bururi forest in Burundi, jointly with U.S. Peace Corps, the proposed collaborative efforts with the World Wildlife Fund in Madagascar, and on-going conservation activities elsewhere in Africa with this same organization.

5.5 Preliminary agenda

Based on the combination of endemism and risk of loss it appears that the four priority subregions:

1) Madagascar/I.O. Islands (Comoros) - Due to the highest rate of endemism and second highest risk of loss.

2) African highlands (East and West). Due to the second highest rate of endemism and third highest risk of loss.

3) Arid/Semi-Arid Subregion. This is in respect to potential loss of crop genetic diversity and national and international importance of freshwater and coastal wetlands.

4) Coastal Humid Lowlands. Due to the immediate risk of loss of the subregion's tropical forests within the next 20 years.

Based on the subregional issue assessment for the priority subregions, the following key items require attention. (See tables for a list action needs in more specific detail).

International - Establish a consensus among donor groups and NGO/PVO organizations as to priorities and responsibilities inddressing the issue of genetic and biological diversity. The value would be similar to recent gains in the forestry subsector.

USAID

Several preliminary recommedation can be advanced:

Increase the emphasis in the Bureau for Africa placed on biological and genetic diversity in AID's program development process for priority sub-regions and countries and in country development strategies.

Strengthen the technical capabilities of the Bureau and Missions and most importantly, host countries to identify opportunities for addressing the diversity issue particularly through the multi-sectoral planning process.

Continue to work with groups such as IPBGR and TNC to establish local data centers which can be used by donor groups and, more importantly, local governments to establish programs and support environmental assessment activities.

Sub-Regional focus

Work closely with countries within priority subregions to improve the legislative and organizational structure so as to establish positive links between conservation and development. This includes improving specific and inter-sectoral skills and communication. Part of this is strengthening of educational institutions with experience in biological or resource planning.

Actively support the management of protected areas, particularly in natural forest management for multiple use, endangered species management, and *in situ* conservation of genetic resources. The U.S is a world leader in these areas. The general trend has been a declining interest in financing such activities by donor groups.

AID should continue to work closely with NGO/PVO groups as with Wildlands and Human Needs Program matching grant to WWF/USA, so as to lessen pressure on critical areas through projects that stabilize resource exploitation in lands immediately adjacent to them..

Table ___ Biological Diversity: Priority Subregions, Countries and Categories Where AID Technical and Financial Support Would Be Most Effective

*** = Immediate
** = Medium Term
* = Long Term

Priority	Subregion	Country(s)	Pol.Dia.	Ed.Prog.	Inst./ Train.	Res./D.C./ Inventories	Prot. A. Mgt.	Wld./ H.Need	NGO/ PVO	Reg. Strat.	I.D. Plan.
1	Madagascar and I.O. Islands	Madacascar	*	*	**	***	**	***	**		***
		Comoros	***	*	?	**	***	*	?		***
2	African Highlands	Rwanda	*	**	**	***	**	***	**		***
		Cameroon	*	*	*	*	**	**	*		***
		Guinea	***	*	**	***	*	*	*		**
		Malawi	*	*	*	*	**	*	*		*
3	Estuarine/ Inland Wetlands of Semi-Arid, Sub-humid Tro-pical Up-lands and Coastal Humid Tropics	Mauritania Senegal Guinea Bis. Gambia Mali Sudan Chad Zambia Botswana Malawi Lk.Victoria	***	*	**	***	**	*	**	***	***
4	Coastal Humid Tropics	Ivory Coast	*	**	**	*	***	**	*		***
		Liberia	**	*	**	**	*	***	**		***
		Gha.	*	*	**	*	**	***			*
		Guinea-Bissau	***	*	*	***	***	***	*		

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Table __ Plant and Animal Genetic Resources for Inventory and Project Priorities for Agricultural, Wood and Energy Production

Priority	Subregion	Key Country Groups	Plant/ Animal Domesti-cation	Potentially New Genetic Varieties By Subregion					Wood/Energy Production
				Sorghum	Millet	Pigeonpea Chickpea	Cowpea	Forage & Grass	
1	Arid/ Semi-Arid	Sudan Kenya Tanzania Chad Mauritania Somalia	**	***	**		***	***	***
2	African Highland	Ethiopia	*	***	**	*	**	***	***
3	Subtropi-cal Uplands	Uganda CAR Botswana Zambia Zimbabwe	***	***	*	*	*	*	*
4	Humid Coastal Lowlands	Ghana Liberia	***						**
5	Humid Equatorial Lowlands	Cameroon Zaire	**						*

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Support independent or project related inventories and applied research within critical subregions to better provide for biological and genetic development within the context of development and increasing land pressure.

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6.0 Stresses on Natural Resources and the Environment Coincident with Drought

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6.1 Introduction

The prolonged period of below normal rainfall that began in 1968 in Sahelian Africa is the worst drought of this century in more respects than its duration. It is taxing the institutional capacities of newly independent nations. And it has coincided with an economic crisis driven by high oil prices in the 70's, high interest rates, and low commodity prices. The combined effect of these forces is not readily distinguished from the stresses wrought by drought alone on the environment.

It is safe to say, however, that to the extent that below average rainfall is an expected and recurring event in much of semi-arid Africa, the flora and fauna, as well as traditinal agrarian or pastoral peoples, have co-evolved accordingly and display amazing resiliency. Nevertheless that resiliency has been stretched to its limits by the recent drought.

"Below normal" and "average" are poor descriptors. More accurate would be the use of standard deviation, or variance, which can be up to 40% or more. Thus, a drought year would be one with rainfall below the lower level of variance.

Much has been written and reviewed recently on the drought in Africa(World Bank, 1986; WMO, 1986; GTZ,1986). An expert committee convened by the WMO, chaired by the Canadian climatologist Dr. Kenneth Hare, summed up knowledge about the African drought in 1983(WMO, 1983):

Drought is a common occurence in many parts of Africa, but the conditions necessary for the onset and cessation of the African drought are not yet fully understood. Causal mechanisms are being actively researched and should be explained in the next several years.

No periodicities or trends exist upon which drought can be predicted.

No known method exists to reliably predict the continuation, cessation, or recurrence of drought in Africa.

Reliable and continuous weather data do not exist in many parts of Africa, and drought warning is handicapped.

All African nations should establish plans to detect drought and alleviate its effectg on agricultural production(i.e. rennovate deteriorated data-gathering networks, analyses of rainfall data to determine probabilities of rainfall amounts and timing, early warning systems to detect meteorological drought and to analyze likellihood of agricultural drought, etc.)

FAO has established an early warning system to detect the likelihood of crop failure in a given rainy season and USAID has also recently contracted for the development of a Famine Early Warning System that seeks to detect early signs of malnutrition, and related socio-economic factors as well as physical conditions as detected through satellite imagery of vegetation changes.

Systems to monitor the deterioration of soils and vegetation and detect thresholds of irreversible damage do not yet exist, however.

6.2 Drought related stresses on the environment

There is wide agreement that drought exacerbates, but does not cause, environmental degradation and desertification. Rather the stress comes from unrelenting pressures of people and much of their livestock on the soils, groundwater and vegetative resources during a period when these resources become temporarily non-renewable for lack of rain.

Over 50% of Sub-Saharan Africa is within the arid and semi-arid clmatic zone, subject to periodic and long term drought. Ninety million people are calculated to reside in this zone, depending mainly on rainfed farming for food.(Table II.).In addition the highlands of Ethiopia, Kenya and even normally moist Rwanda are subject to drought. During the most recent drought episode(1981-85), crop failures extended into neighboring sub-humid zones. A total of 130 million people were judged to be at risk.

The peoples in this region have evolved various cultural and technical responses to the high variability of rainfall in the region: pastoral nomadism, food stores, sharing of surplus, etc. By such means a number of poor harvests can be tolerated. However, the occurence of several low rainfall years cannot be distinguished from the onset of a long drought. Only when food stores have been exhausted and fodder sources too scarce to support herds does the impact of drought seriously threaten people and livestock.

Before this occurs, however, the vegetation, soils and groundwater reserves will have already been stressed by continuous use during several years of poor rains. These stresses include:

*over-pruning and over-browsing of bushes for fodder and fuelwood.

* destruction of natural regeneration of various woody tree or browse species.

* reduction of crowns of larger trees. Boys climb them and prune the branches for use as fodder and fuelwood. This damage is irreparable on most species, the exception being the neem tree.

* lowering of water tables

* loss of organic matter in soils, a consequence that is really the exacerbation of a long term trend affecting the farmlands of semi-arid Africa.

Ironically, some kinds of emergency food aid inadvertently assist the process of environmental degradation, by allowing people (and their resident livestock) to remain in their villages. Thus people may be sustained by emergency food and by

deepening wells, but the tree and other woody vegetative cover suffers doubly, for not growing and for the burden of providing not only daily firewood needs but all animal fodder needs, there being li tle or no crop residues or annual grasses.

The habitability as well as the ecological resilience of arid and semi-arid tropical Africa is first and foremost a function of the presence of trees and other deep-rooted ligneous species that tap deeper soil horizons for moisture and nutrients. They are a key to understanding the environmental stresses coincident with drought. They are the fuel and fodder reserves of below normal rainfall years as well as of the long dry season.

Habitabiity is also a function of the shallow groundwater resources of the zone, and of course, its food producing potential. Food, however, turns out to be the least important determinant of habitability, at least as to the extent that food aid is provided.

The impact on irrigation is worth noting. The drought has jeapordized traditional and modern irrigation works alike, and combined with declining economic health of the countries in the zone, has delayed water development, or even set it back. In the Senegal River's lower valley, for example, intrusion of saline water from the sea upstream has made it impossible to use river water for large scale projects. Estuarine rice farming in Senegal and Gambia has also suffered for lack of freshwater inflow. Low barrages to bar tidal movement are being built to counter this effect. In general, however, the minimal development of irrigation in the drought-prone states has meant a limited impact due to drought.

6.3 Dryland farming regions.

These are located in the semi-arid tropics -- 75 to 180 day growing season, corresponding to rainfall values between 275 and 800 mm.

In dryland farming regions droughts temporarily reduce the carrying or supporting capacity of the environment to sustain people and livestock. Yet, sedentary agrarian Africans are loathe to leave their villages and lands until they have become desperate -- as happened during the kinds of famine that killed 300,000 in Ethiopia in 1984/85 --they will continue to graze or browse their animals, cut firewood and draw water, while drawing down their food stores. Neither the vegetation nor the water table is being renewed by rain. Both dwindle under the daily pressure, and essentially become non-renewable resources for the duration of the drought.

Tree crowns are steadily pruned for their forage, lesser bushes are browsed to the ground, crop residues -- if any -- are burned or eaten by animals rather than plowed back into the soil. Also, trees and annuals less tolerant of drought wither and die. This process, which ultinmately results in a reduction of biological productivity is desertification. It is going on in arid and semi-arid Africa even without the drought, but droughts greatly accelerate the effect of unsustainable levels of vegetative and water resource exploitation.

The various uses made of trees and other woody vegetation have been described. Their ecological role in providing resilience to this dry environment is equally important. Evenly spaced trees whether on agricultural or natural landscapes interrupt and buffer the energy of wind erosion. They shade the ground and reduce soil temperatures, reducing evaporation and rendering the soil more habitable to micro-organisms, which feed upon dead leaves, twigs and other litter. The action of termites is illustrative.

Dr. Robert Chase of Texas A and M discovered in land treatment experiments for AID in Niger that dead twigs and branches laid upon bare soil attracted termites who colonized the underlying soil, rendering it more porous and able to accept rainfall thereby increasing its productivity as rangeland(in this instance)(Tropsoils 22). Fallen, dead branches and twigs are not to be seen within walking distance of villages, however, especially during droughts. All have been collected for cookstoves.

Thus, in a general sense the resilience of the semi-arid regions to drought becomes fraved and weakened as trees and other perennials are cut back and disappear. Thus, when the current drought cycle ends, the regions will nevetheless be more vulnerable to aridity than before. Also, they'll be more vulnerable to water erosion from the strong rains that may fall, for lack of vegetative cover.

The next ecological thread to unravel during droughts is the one connecting crop residues, manure and soil fertility as influenced by organic matter. As fuelwood and forage from trees becomes scarce, crop residues are also diverted to the cook stove or fed to animals.(Crop failure, i.e. zero growth, is rare, even during major droughts and stalks and vines will grown even though harvests are slim).

Manure may also be burned. Normally it is left where it is deposited on fields surrounding villages, by herds corraled at night after watering. These are often the most productive

fields, reserved for continuous cultivation of grains. A reduction in livestock numbers during droughts also results in less manuring.

The recent drought only exacerbated a trend towards fewer cattle
in dryland cropping zones, as a result of reduced areas of fallow -- used formerly as wet season grazing reserves.

The productivity of croplands is diminished as it is deprived of additions of organic matter as crop residues, manure or even roots. Plants may be up-rooted instead of cut off, so as to get the maximum amount of vegetative matter for fuel or fodder.

Semi-arid zone sandy soils in particular need organic matter. Its loss as well as the associated loss of humus(decomposed organic matter) reduces the capacity of soils to hold water and nutrients(cation exchjange capacity). Even if nutrients were supplied through chemical fertilizers, they could not be retained. Humus is especially important for imparting cation exchange capacity to sandy soils since they lack clay.

Urban demands for fuelwood in Africa exacerbate the ecologicalunravelling of this zone by loss or degradation of vegetative cover(Gorse, 1985). Moreover, as in the case of food staples, government-imposed price ceilings set at low levels (to favor the urban poor) can act as disincentives to resource conservation. Low prices discourage efficiency of cutting and charcoal manufacture, as well as of fuelwood or charcoal use.

6.4 Rangelands

All the stresses on African rangelands and their various forage or browse resources coincident with drought are in effect exaggerations of the consequences of the longer term, lower level stresses caused over time by decreasing range resources and growing herds.

Stresses on rangelands coincident with drought are on the surface self-evident --i.e. reduction in the amount of growth of annual grasses in particular -- but at the same time can be subtle -- i.e. a shift to dominance of more species more tolerant of arid conditions. In general, however, rangelands in Sahelian Africa and its extension into Sudan are quite resilient . Further over-exploitation of range is limited to zones with dry season watering points. Thus most arid zone range is untouched by livestock -- a circumstance that has generated various schemes for establishing temporary water supplies.

Where deep water has been tapped however, the surrounding landscape becomes seriously overgrazed and overbrowsed -- to the point of becoming desertified -- to a distance of a one day walk by browsing cattle (who can survive two days without water).

African pastoralists have evolved herd management to cope with the erratic nature of arid zone rainfall and resulting variable range productivity(GTZ, 1986). They are highly mobile and nomadic. They are opportnists. They "stock" i.e. herd as many animals as possible on the range resource and move on. They do not manage the range resource in fact; they manage their herds. Their primary goal is subsistence, not maximum gain per animal, especially during droughts.

Since nomadic herders will relocate to more humid zones during severe droughts, the stress of drought on arid range is a natural one, within the evolutionary history of the regions. Far more stress is caused in minimal rainfall years that nevertheless are not drought years. During such years herders continue to migrate through their customary ranges. Woody browse species in particular are likely to suffer.

Social conflicts with resident farmers at the borders of the Sahelian range and in more humid zones are probably the key sort of stress associated with pastoralism during drought periods, and increasingly during "normal' periods. Some went as far as Cameroon during the 1973/74 drought. Conflicts in Sudan are especially serious(Khalifa, et al, 1985). In fact all across the Sahel the period of above average rainfall years in the 1950's and early 1969's had encouraged farmers to move into the former domain of nomads, and occupy lands that were formerly dry season grazing reserves. Conflicts had arisen even before the drought.

An increase in numbers of sheep and goats during droughts may occur, with detrimental effects on low growing browse species.Small ruminants survive and re-build their numbers more readily than do cattle. Pastoralists will trade them for cattle. The overall effect on browse resources can be deduced, but has not been documented.

The sinking of boreholes to counter lack of water and the subsequent lack of range management in their environs has probably caused as much stress as any other factor on arid rangelands.

In East African arid range, where the double rainy season results in the possibility of perennial grasses, these become overgrazed to the point of disappearance.

Taken together, these various processes that are triggered by drought undercut the ecological mechanisms that lend resilience and stability to the agricultural and pastoral landscapes in this difficult environment. The extreme result is total loss of biological productivity, or desertification. Ironically, this is more a problem in the somewhat more moist inhabited zones than at the margins of the true desert where human and livestock pressures are minimal or absent during droughts.

6.5 Development responses to drought-induced environmental stresses

Dramatic successes in stabilizing sand dunes that threatened oases and villages were achieved during the post-1968 drought period.The idea of a green belt of trees across the Sahel has been seriously proposed time and again. And the "first generation" of projects launched through the Club du Sahel and CILSS did recognize the importance of fuelwood demands and their relationship to deforestation. But most efforts focussed on developing potable and irrigated water sources, restoring herds decimated by the drought, and increasing food production.

Over ten years of forestry developement projects following the drought have shown moreover that:

(1)Trees alone do not stop sand dunes and the spread of desert sands. Initially palisades(grass or brush windbreaks) and ultimately groundcover are the only means of arresting drifting sand. A cobination of trees and groundcover is ultimately the best protection.

(2) Fuelwood plantations alone cannot solve the fuelwood crisis of the region. (good land is scarce; growth is too slow)

(3) Exotic, "fast-growing" eucalypts cannot outperform indigenous trees (or Prosopis) at rainfall below 800 mm annually.

The narrowly focussed objectives of these initial efforts failed to account for all the uses and ecological services provided by tree cover on the total landscape, and technically operated out of ignorance, for lack of adequate research and cutting trials.

Drifting sands do ultimately threaten much of the millet and peanut growing belt across the Sahel, but they represent a

rather advanced stage of environmental deterioration. We must replace our concern for drifting sand dunes with one for the earlier stages of the insidious and difficult-to-reverse unravelling of the agroecosystems of this region, as trees and lesser woody plants disappear from fields and grazing reserves, and soils are rendered unproductive.

A development response to this essentially systemic problem has not yet been set forth. Research and development have attacked individual facets of the semi-arid agroecosystem, e.g. determination of range and woodland productivity, fuelwood planting, manipulation of soil micro-organisms, development of more efficient woodstoves and charcoal kilns, crop residue management, soil moisture management, and agroforestry. These have been scattered efforts, lacking an overall research or development hypothesis that could serve to integrate efforts.

It is understandable that combatting desertification was an effective banner for organizing emergency responses to drought. Now, however, "reversing Africa's decline" may more aptly apply to drought-stricken regions in the process of economic and environmental rehabilitation. Certainly, the restoration of trees and other perennial woody species will require years of commitment, innovative and experimental efforts, as well as ordinary protection and conservation on a tree by tree basis in many instances.

A parallel challenge is posed to agricutural development. It must be designed to be supportive and contributory to environmental rehabilitation while also holding the goal of increasing food production. In fact, the two are mutually dependent ~~to the~~ and in practice must be combined in a single action by the farmer and a unified supporting action by development agencies.

As regards a development response to the problem of stressed rangeland resources, there has been a singular lack of progress on the practical plane. Some promising research is underway, however.

On-going and planned development assistance responses to this situation are surveyed in the description of the ASA sub-region.

6.6 Preliminary Recommendations

Assuming the worst of the drought begun in 1968 is over, the particular crises it engendered will pass. However, the resulting crises in dry season forage and in fuelwood will remain for the a number of years. Long term rehabilitation

actions on these two issues are the best response(see recommendations in the sub-regional treatment of the arid and semi-arid subregion).

It would be wise at this point to encourage drought prone nations to prepare a drought contingency plan, dealing with not only food, livestock and seeds, but also fuelwood and forage, which as was shown above, can be fatal demands for vegetation in droughtyears.

Drought-prone nations should also have in place a contingency public works plan to occupy rural peoples affected by drought.

Similarly, AID should have in place a contigency plan for employing PL 480 food in concert with African governments to finance public works, such as watershed terracing, during drought years. Numerous examples, including Cape Verde, indicate how effectively this can be employed.

AID's new Famine Early Warning System monitoring project could be expanded to interpret indicators of not only nutritional and food status but environmental and geophysical indicators of impending drought periods. Continuing support for research to predict long term climatic cycles is needed.

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III. Sub-Regional Overview

A. Introduction

Sub-Saharan Africa's diversity causes the natural resources management problems described in the previous section to vary greatly from one place to another. However, they are more or less of similar nature and magnitude in sub-regions with climatic and demographic similarities.

In this section the various issues presented earlier are discussed for the specific ecological circumstances pertaining to the various sub-regions, selected for their environmental homogeneity.

Each sub-region is described, development responses or activities are noted, possible additional solutions are listed, apparent constraints or gaps to more assistance are mentioned if these are identifiable, and preliminary recommendations for AID consideration are presented.

Identification of sub-regions

An attempt was made to employ the sub-regional classification used in the 1985 "Plan for Supporting Agricultural Research and Faculties in Africa". However, it did not prove of sufficient accuracy for the sub-regionalization of natural resources management problems. In that plan, sub-regional country groupings correspond to a general matching of countries with kinds of major food crops to be researched, and the ecological classifications are not entirely accurate. This is perhaps of little consequence for the research plan but hinders the identification of suites of resource management problems corresponding to different ecological zones.

For instance, Lesotho and Swaziland are identified as modified tropical highlands; in fact they are well within the subtropical latitudes. Botswana is identified as sub-humid tropical, which is true in part, but most of Botswana is the semi-arid to arid Kalahari desert, whose southern portion extends into the subtropics. Somalia is identified as Semi-arid Tropics, when in fact it is arid to hyper-arid over most of its territory.

For the present plan, seven homogeneous sub-regions were indentified on the basis principally of agro-climatological criteria, but also taking into account population densities and floristic endemism, or uniqueness. Dense populations on the West African humid coast differentiate it from the humid equatorial states of Zaire, Congo and Equatorial Guinea. The reknowned floristic uniqueness and insular characteristic of Madagascar and other Indian Ocean islands justified their designation as a distinct sub-region.

Agro-ecological regions defined and mapped by FAO in its Agro-ecological Zones Project were used to establish sub-regional boundaries(FAO, 1978). The resulting sub-regional classificationis as follows.

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Sub-regional map (page size)

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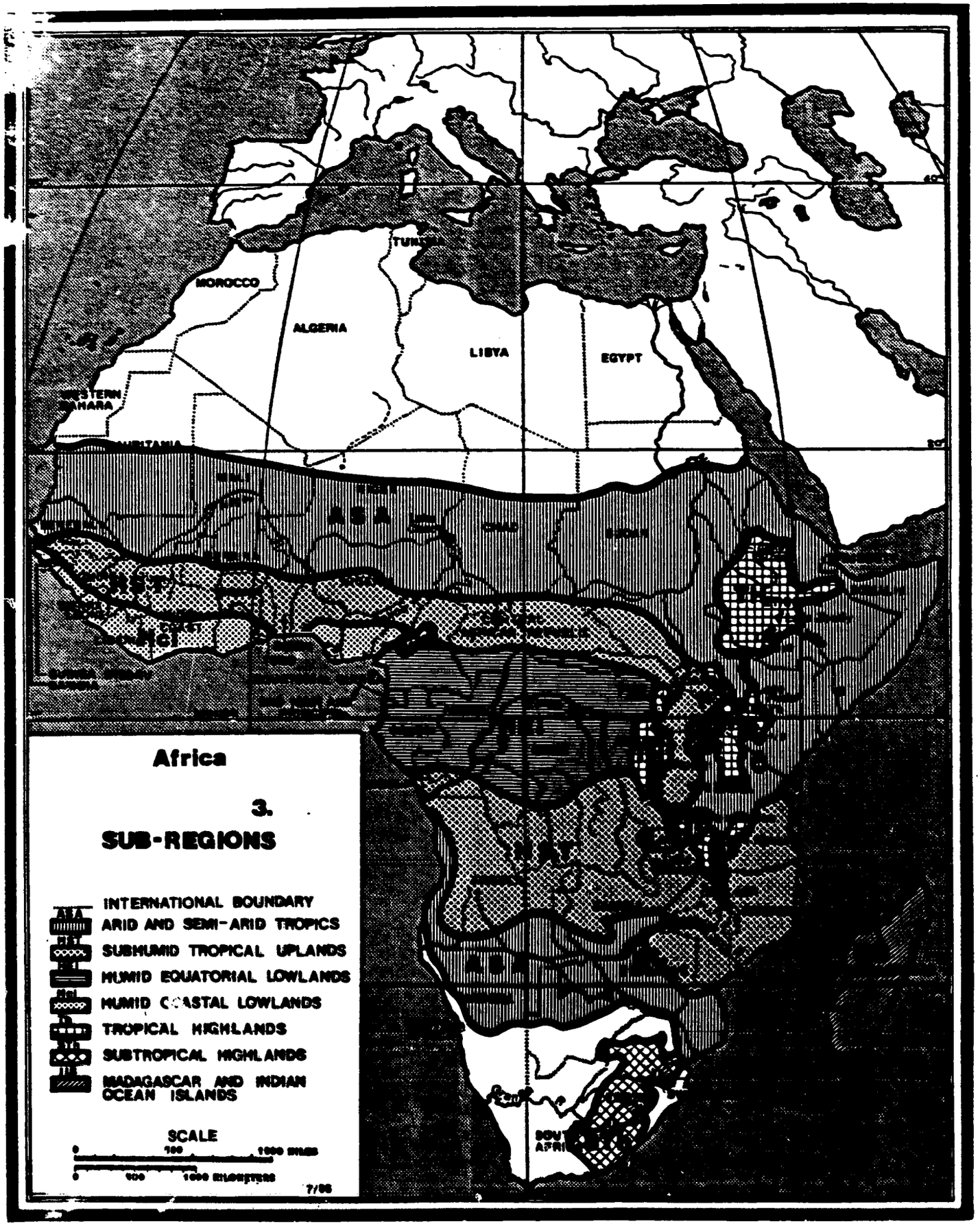
Arid and semi-arid tropics

Length of growing season is 0 to 180 days. Rainfall in the arid zone supports some vegetation but rainfed cropping does not take place at less than about 350 mm which corresponds to a growing season of about 75 days. The belt from 75 days to 180 days is considered to be the semi-arid zone in this classification. In West Africa the 75- to 180-day growing season zone corresponds to the Sahelo-Sudanian and Sudanian zones, while the climatic Sahel occurs north of the 350 mm line and grades into the Sahara.

Sub-humid Tropical uplands

Length of growing season is 180 to 270 days. The sub-region generally embraces the upper portions of river basins, whose elevations above sea level do not exceed 1000 meters, and more generally are 100 to 300 meters.

A more rigorous climatic definition of this expansive sub-region would probably find the portions south of the equator to be subtropical rather than tropical, where higher elevations result in slightly lower temperatures, i.e. the Zambesi plateau. However, for simplicity the subtropical designation follows that used by FAO, which refers only to sea-level temperatures.


Africa
3.
SUB-REGIONS
INTERNATIONAL BOUNDARY
ARID AND SEMI-ARID TROPICS
SUBHUMID TROPICAL UPLANDS
HUMID EQUATORIAL LOWLANDS
HUMID COASTAL LOWLANDS
TROPICAL HIGHLANDS
SUBTROPICAL HIGHLANDS
MADAGASCAR AND INDIAN OCEAN ISLANDS
SCALE
MOROCCO
ALGERIA
LIBYA
EGYPT
ASA
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Humid equatorial lowlands

Length of growing season is 270 to 365 days. Population densities are generally light.

Humid coastal lowlands

Length of growing season is 270 to 365 days. Populations are dense and include a number of large cities: Lagos, Accra, Abidjan.

African Highlands

Length of growing season is variable, and cool temperatures as a function of altitude are the distinguising characteristic. Elevations are generally above 1500 meters, and temperatures are less than 20 degrees C. during the growing season. There are two rainy seasons. Steep mountainous terrain predominates.

Subtropical Highlands

Elevations of 1500 meters or more predominate. Terrain is moutainous or rolling high elevation plateaus. Only Lesotho and Swaziland are AID recipients. The rest of the Sub-region comprises South Africa.

Madagascar and Indian Ocean Islands

(The other islands are the Comoros, Mauritius, and the Seychelles.)

During continental drift Madgascar separated from Gowandaland, which included Australia, rather than from Africa, which drifted away from South America. Hence its floristic uniqueness. Madgascar's diverse climates mirror all the climates on the African continent. Typhoons are major climatic events for these islands.

Table III.1. Sub-regional areas

(millions of ha)

Arid tropics	553	
Semi-arid tropics	386	
total		939
Humid equatorial lowlands and Humid coastal lowlands		424
Sub-humid Tropical uplands		278
Highlands of East Africa and Cameroon		97
Madagascar		58

Source: FAO, 1978. Report on the Agro-ecological Zones Project, Vol. I, Methodology and Results for Africa. Rome. FAO.

1.0 Sahelo-Sudanian zone and Other Arid and Semi-arid Tropics.

Contents

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1.1 Description

This is presently the most critical sub-region in sub-Saharan Africa, due to the urgency of solving the many natural resources management problems that it faces, and that must be resolved as a pre-requisite to sustainable development. The principal problems are: scarcities of water, fuelwood, accessible range, and arable soils; degradation of soil and vegetation, leading to desertification; and erratic food production.

Its area(12.4 million sq km), the numbers of peope and livestock in this sub-region(90 million and 77 million, respectively), the variability of its productivity, and the decline in productivity because of desertification, makes this the most critical sub-region on the African continent.

Of 19 countries in the Sudano-Sahelian zone, only Guinea and Guinea-Bissau report stable conditions; eight countries report some increase and nine report a significant increase in desertification (WRI 1986).

Development banks as well as development agencies and private voluntary relief organizations all realize now that reversal of the environmental decline in this sub-region is a key requisite for sustainable improvements.

The sub-region is in places densely populated(up to 60 to 100 per sq km) and can be very productive. Also population growth has continued unabated notwithstanding the long drought that dominated the period 1968-85. Except for Senegal, where 1 in 6 persons live in cities, the sub-region's people are mostly rural dwellers. They comprise a very diverse cross section of humanity, including the Peul, and Masai pastoralists as well as hundreds of culturally distinctive agropastoral societies, deriving subsistence livelihoods from this erratic environment.Many are of the muslim faith.

Virtually the entire ASA region is considered by FAO to be over-populated in terms of sustainable rainfed food production at low levels of inputs,i.e. traditional farming)(FAO, 1980). The drought has dramatized this relationship, and major relocation of populations from the drier northern regions to cities or more humid southern regions has taken place.

Climatically the sub-region lies between the 0 mm and the 800 to 1000 mm isohyets or, in terms of the length of the growing season, between 0 and 180 days. The Semi-arid tropics are usually defined as having a 75- to 180-day growing season(ICRISAT, 1984).

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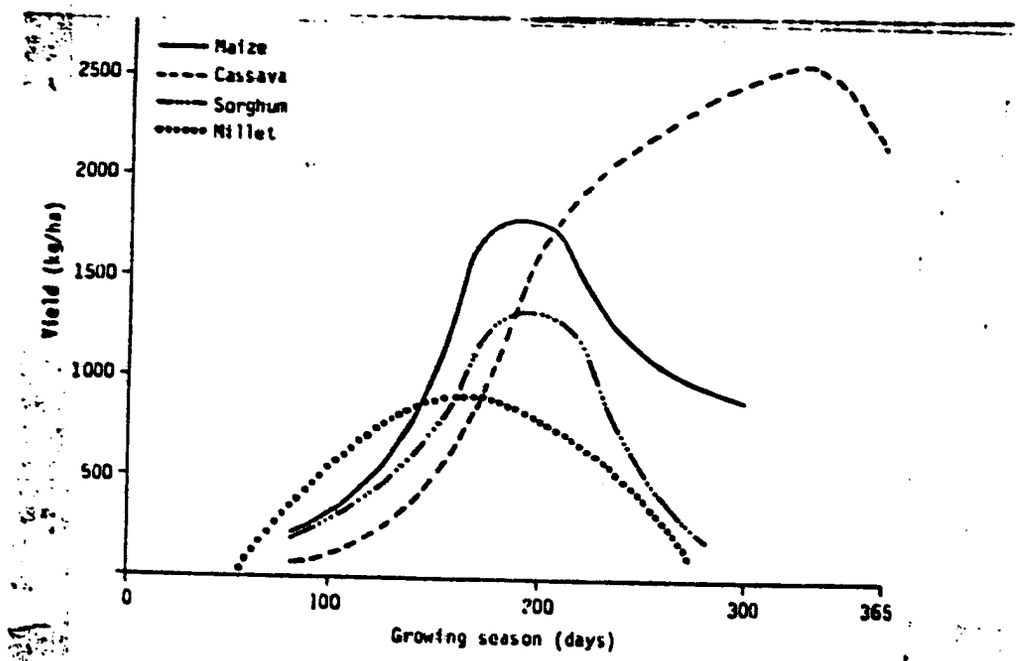

Figure 2. Fluctuations of average yields of millet, maize, sorghum, and cassava in relation to available lengths of growing season.

Fig. III. Fluctuations of average yields of millet, maize, sorghum and cassava in relation to growing season.

The shortest growing period in the African tropics is in the rainfall range of 275 to 300 mm, or from 75 to 90 days. However, at this extreme rainfall variability results in an indistinct transitional zone some 50 to 75 kilometers wide, marked by the last signs of rainfed millet cultivation(see figure). In the Sahelo-sudanian zone the northern limit of cultivation shifted south about 100 kilometers during the recent drought, that began in 1968.

The arid and semi-arid climatic belts were combined into a single sub-region because of the long history of inter-dependency of the pastoral, agro-pastoral and agricultural groups that span the two climates.

According to UNESCO's world classification of desert regions, (UNESCO, 1979), the climate is characterized by a single summer rainy season, except in Ethiopia and Somalia. Temperatures are highest in the Sahelo-sudanian zone(SSZ) in both winter(around 25 degrees C) and summer(on average in excess of 30 degrees C). In fact the Sahel is the hottest inhabited desert in the world

because of the unrelieved high temperatures.

The ASA south of the equator, has a cooler winter season, between 10 and 20 degrees C, and summers are not quite as hot, even on the Khalahari desert where mean temperatures of the warmest month rarely exceed 30 degrees C. As a result aridity is somewhat less than in the Sahelo-sudanian zone. Except the hot deserts on the Horn of Africa, the ASA of east Africa is also less hot and less arid than the SSZ. The Cape Verde Islands are included in this zone, and southwestern Madagascar is also semi-arid.

Average or mean values of rainfall have little meaning in this zone because of the characteristic high variability within a given rainy season and from year to year. Expected departures from mean values are on the order of between 25% to 50% or 60%. On the arid side of the zone, rainfall occurs as spotty local showers rather than as frontal storms. The latter shed rain more uniformly over large areas, and only occur in the humid extremes of this sub-region.

Aridity, the result of temperature and humidity, is a more precise definition than rainfall alone, since portions of this sub-region occur at elevations in Kenya of up to 1,500 meters where cooler temperatures prevail and rainfall is more effective than at lower elevations.

Aridity in the sub-region ranges from:

$$0.03 < \frac{P}{ETP} < 0.50$$

In other words evapotranspiration potential in this sub-region is on the arid extreme 33 times the amount of rainfall and on the humid boundary only 2 times the rainfall. Within the rainy season, precipitation exceeds evapotranspiration potential, and the surplus either percolates into the soil horizon or runs off. Obviously moisture storage in the soil horizon of arable lands is desired, and soil management for rainfed agriculture in this zone emphasizes techniques that enhance storage.

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box

Actual evapotranspiration is a second useful measure. It registers how much is actually evapotranspired from soil surfaces and through plant pores. This in turn is a function of the moisture from rainfall retained in the soil and available to plants. Thus, a soil which has lost porosity becomes more arid than a neighboring soil that has retained porosity and can

store more water and support a more abundant vegetative cover. Also, deep rooted plants in sandy desert soils have an obvious advantage over ones whose roots are in surface horizons where evaporation removes water, e.g. the first meter approximately in most soils. Deeper roots can tap stored groundwater during the long dry period. Therein lies the value of trees, no matter how small in size, in the desert.

Transpiration may be less on infertile soils, especially nitrogen poor soils, since they don't support he vegetative growth that is climatically possible. This is true in the Sahel(Brenan and de Wit, 1983) where water would appear to be a limiting factor as well as in more humid zones.

<u>end box</u>

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Vegetation in the sub-region ranges from ephemeral grasses in the true deserts of the Sahara and the Kalahari, to semi-deciduous wooded savannah on the humid boundaries. Perrennial grasses occur at rainfall amounts in excess of 800 mm where there is a single rainy season. In the climatic Sahel perennial grasses are limited to clay-filled interdunal depressions, permanently wet valley bottoms or swales(bas fonds), where they supply important sources of forage for migrating cattle.

The wet pastures of various inland deltas and shallow lakes are also strategically important dry season reserves. These same wetlands are overwintering habitats for European waterfowl and in the future could be the target of major irrigation schemes. Traditional irrigators and farmers have already occupied the better soils.

Important parks have been established in Senegal, Niger and Botswana to conserve wetlands as well as range important to wildlife.

In double rainfall regimes of the East African portion of this sub-region, permanent grasses can survive at lower annual rainfall than in the Sahel. Pasture and livestock management vary accordingly.

Wood growth in natural formations ranges from 0.5 cubic meters per year or less, to 20(?)cubic meters per hectare per year on better soils and at higher rainfall of 800+mm.

Although there are relatively few endemic species of plants and animals in the arid and semi-arid zones, some are of critical importance to the future of agriculture, forestry and grazing: domesticated and wild sorghums and millets, browse and tree species. Little collection or research has been done with them.

1.2 Soils and land degradation

Soils present complex management problems of dryland farming but they are not well mapped in the sub-region.Small scale(1:1,000,000 to 1:250,000) soils surveys are gradually being carried out in the ASA north of the equator -- Senegal(1:250,000), Mauritania(1:), and Mali(1:500,000 partial coverage) are examples. All were financed by USAID and utilized satellite as well as aerial photographic imagery in addition to field surveys and previous maps. FAO has mapped degradation and desertification hazards at the 1:25,000,000 scale. These scales are suitable for national or regional planning but not farm level work.

Soils are very diverse but share a common low content of phosphorus and organic matter. Low contents of organic matter seem to be a recent problem, i.e. in the last 25 years, while phosphorus deficiencies are an innate characteristic.

In a monograph on Africa's dryland soils prepared for AID,H.E. Dregne summed up the major characteristics of the sub-region's agricultural soils(1982, p. 15):

* Low inherent fertility is the most significant and pervasive problem.

It arises from the sandy and acidic character of soil in the Sahel zone and from the low nutrient holding capcity and high phosophorus fixation capacity of the ferruginous soils in the more humid portion of the zone.

Nitrogen and phosphorus are limiting nutrients. Sulfur can be deficient for some crops in the more humid margins; micro-nutrients can also be deficient and limit plant growth.

* Soil surface crusting is a problem everywhere. It is not easily solved; organic matter can reduce crusting but it's virtually impossible to maintain. Post harvest plowing could help, but on dry soils plow penetration is a problem.

* Hardening(not just crusting) of the top layers is especially serious in southern Africa.

* Drainage is poor on the clay plains of Sudan and Chad, and long the Angola-Zambia border.

* Vertisols(black cracking clays) are poorly drained in Sudan, but have good crop potentials.

Australian experience in mechanized cultivation of vertisols is being adapted to conditions in Somalia with good results in a World Bank project(McPherson, 1986)

* Low organic matter is a fundamental fertility constraint, which among other effects, limits the value of mineral fertilizers. Crop rotations and better management of crop residues and other source of organic matter are solutions.

* Unlike some other arid regions of the world, there are practically no salt problems in the dryland soils of Africa.

1.3 Degradation of vegetation

The scant vegetative resources in the subregion support both people and livestock. Continuous harvesting of perennial species for fuel, lopping of branches for fodder in the dry season and occasional cutting of poles and grasses or palm fronds for construction(supplementing the customary use of sorghum stalks for shelter walls) are principal means of exploitation.

Current rates of fuelwood harvesting are not sustainable(World Bank, 1985)(See discussion below on fuelwood as a limiting factor,section II.B.6)

Livestock browse perennials grasses or woody browse species during the long dry season, or crop residues if herded to farming regions. The slow disappeance of desirable browse species has been observed in one of the few surveys which have monitored this resource(Senegal 1984).

Burning is a problem in the zone. Nomadic herders burn dry grasses at the end of the growing season to promote a "bloom" of fresh shoots that tap residual groundwater. Hunters also employ fire. Fires can of course get out of control. Dry season browsing and grazing reserves also are in or near forest reserves. "Brush fire" control is a major concern of the forest services in the Sahelian states.

The ecological result of burning is destruction of seeds, of more tender re-growth including shoots of woody plants which have germinated during the short rainy season, destruction of organic matter, and baking of the top centimeter of soil surface, with a destruction of micro-biologic life. Progressive xerification of the site takes place, i.e. local edaphic and micro-climatic aridity in excess of what overall climatic conditions indicate.

1.4 Water resources

Greater use and better management of water resources in this sub-region will be a key element in efforts to achieve a measure of food self-sufficiency. Various traditional means of using water for subsistence crops have evolved over the centuries; some are in conflict with modern development, such as flood recession farming, widely practiced in the Senegal and Niger River Basins, as well as lesser rivers.

Three of Africa's major rivers flow through the sub-region: Senegal, Niger, Blue and White Nile, and have supported fishing farming and grazing livelihoods throughout human history. Since independence and the subsequent onset of the drought in the Sahelo-Sudanian zone, large integrated development schemes have been proposed for these three rivers. Their irrigated agricultural potentials were and are viewed as a safeguard against future droughts and the vicissitudes of rainfed food production.

These schemes were encouraged during a period of surplus petrodollars and offers of financial assistance from some of middle-eastern oil producers for dam construction, e.g. the Manantalia and Diama dams on the Senegal river. However, they had been the subject of general planning studies in previous years.

box

Irrigation and potential irrigation in countries of the ASA
(Source: FAO, 1985)

Country	Irrigated in 1982	Irrigation potential
	(000's ha)	
Botswana	12	100
Burkina Faso	29	350
Chad	46	1,200
Kenya	49	350
Mali	150	340
Mauritania	23	39
Niger	24	100
Senegal*	187	180
Somalia	85	87
Sudan	1,700	3,300

*USAID estimates the Senegal River valley's potentially irrigable lands at 360,000 ha. for all three riparian states(Senegal, Mauritania, and Mali).

FAO concludes that all of the above countries, except Sudan, will have to count on irrigated food crop production as a major element in future food strategies, in the short and medium term.

end Box

The above river basin schemes have all been delayed by economic crises and political differences among the the Sahelian states in recent years. Also, construction of a canal through the Sudd in southern Sudan has been interrupted due to civil strife; the construction of dams on the Senegal River has proceeded, but parallel planning and development of irrigated agriculture has been delayed by disagreements among the riparian states on the basin's development, as well as a re-thinking on the part of AID and other donors of early commitments to assist in the development of the basin.

Health problems, notably from water-borne or water-related diseases, such as malaria and schistosomiasis, are important complications of irrigation projects in this region, as well as adjacent sub-humid highlands. Incidence of schistosomiasis in Sudan's 1,700-Ha Gezira scheme increased from 9% to 50% between 1940 and 1985. Compelled planting of commercial crops also undercuts the subsistence livelihood of cultivators, especially if government bodies pay artificially low prices for the commodityThis results in poor nutrition with all its complications.

Regarding the scale of irrigation development, the 1985 FAO study concluded that:

> Entirely new, large scale schemes may seldom be economically justified in these countries but there is scope for cheaper rehabilitation ,and in some cases, expansion, of existing perimeters. Simple improvements to traditional swamp and recession irrigation, although giving smaller yield gains, could in aggregate also make an appreciable contribution to food supply.

AID is nevertheless supporting specific projects in the Senegal River Basin aimed at strengthening the OMVS, as well as the development of irrigated agriculture in the Lower Juba Valley, Somalia, presently being planned with the pledge of World Bank financing of a major dam. The AID study includes an environmental assessment of the impacts of land and water development.

The importance of upper catchment areas in the quantity and uality of water flowing into the sub-region's major rivers raises the need for international cooperation, since these rivers have their headwaters in other nation states. The Nile arises in the East African Highlands, as does the Juba River, flowing from Ethiopia into Somalia. The Gambia and Senegal Rivers have their origins in Guinee's sub-humid Fouta Djalon highlands; the Niger River also arises in Guinee, slight further south.

Important issues are raised. The upstream catchment states should seek land cover and landuses that supply clean, regulated run-off ,but they would not directly benefit. Still, if Guinea's and Ethiopia's uplands are to remain productive for agriculture and forestry, land use practices must be followed that will serve not only to conserve soil and water, but regulate run-off. Un-controlled logging and steepland cultivation in remote upper catchments presents a management problem that is not easily solved. In the Gambia River Basin, AID is seeking to provide technical assistance in upper watershed management.

Groundwater resources in the zone include shallow aquifers in the loose soils renewed by rainfall as well as deep aquifers in rock strata. Most rural folk depend upon the seasonally renewed shallow aquifers.Their levels have dropped during the drought and wells have had to be deepened. Deep aquifers have been tapped in recent years for livestock watering in Sahelian ranges.

Knowledge of groundwater resources is rather scant. The groundwater resource of West Africa were mapped by the Centre Inter-Africain d'Edtudes Hidrauliques(Burkina Faso) in the early 70's, using rainfall averages of the preceding period to estimate groundwater potentials. The long drought has compelled a re-assessment of potentials, now underway with assistance from the European Economic Community.

Groundwater is generally too scarce or deep to for irrigation. According to FAO(1985), groundwater yields in the sedimentary basins of Chad and Senegal are intermediate and those in Somalia and Sudan are too deep(over 100 meters) for irrigation sources.

Villages are , however, beginning to irrigate small tree nurseries with shallow well water, formerly used only for drinking and livestock. Vegetables are often raised on a small scale by women in conjunction with nurseries. A local management problem is posed that so far has not been addressed in small scale water development, namely the determination of the rate of draw-down that the local aquifer can sustain. It could be exceeded to the detriment of the local potable water supply in a given season.

1.5 Rangelands and livestock

This sub-region is the principal livestock raising environment of Africa. It is free of tse tse flies, except in the more humid margins and where a combination of perennial streams and riverine vegetation are found, e.g. the Lower Juba River, Somalia(pers. communication with Dr. G. Tillman).

It is also the sub-region which presents the greatest potentials for adapting the traditional association of livestock and farming(which could be described as an antagonistic symbiosis between nomads and sedentary farmers) in order to intensify agriculture. It is here also that a scientific adaptation of traditional agroforestry species and systems to the needs of agricultural intensification presents interesting potentials. A complex but promising research need exists: the integration of trees, livestock and cropping systems. Nowhere are these three elements of traditional livelihood systems being researched.

In the arid portion, where agriculture is not possible,research, surveys and monitoring of range ecology and of livestock projects in the past 10-15 years has not yet been synthesized, but the relatively great ignorance that characterized the state of the art in 1968 is gradually dissipating(e.g. work by G. Boudet in Niger(Boudet, 1977), UNESCO in the IPAL project in Kenya(Luisigi, 1985), Breman and de Wit in Mali(1983), and von Praett for UNEP in the Senegal Ferlo(1985)).

For example studies in Mali in different humidity provinces of this sub-region shed new light on range productivity in the Sahelo-sudanian portion of the sub-region(Breman and de Wit, 1983), as well as the possibilities for rationalizing the integration of farming and transhumant herding. Above 300 mm rainfall, phosphorus and nitrogen, not water, limit greater production of annual grasses. In areas with less than 300 mm lack of water is the limiting factor. However, the quality of the range is higher in the drier portions of the Sahel since protein content is greater.

The above research findings support the logic of transhumant herding between the Sahel in the short rainy seasons and regions to the south in the dry season. Also, they point to the benefits that could be derived from improving the fertility of farmlands to the south with phosphorus and nitrogen so as to not only increase crop yields, but also amount and quality(thus, value) of crop by-products for feeding transient herds following harvests.

In Senegal several livestock development schemes funded by AID were premised on the idea of fattening animals raised in the arid Ferlo and Bakel regions with crop residues, especially cowpea and peanut vines. Small farmers in the groundnut growing regions were to stall feed heifers and later sell them to the Dakar market. For many reasons these projects had very limited success, however, the stall feeding aspects, even though small in scale worked out well.

Sheep and goats are not only more numerous than cattle in the sub-region but are economically as important or more important. Futher, their fecundity makes them especially valuable in recovering herds decimated by drought. Their importance in pastoral and agropastoral systems has not been reflected in development assistance, which has focussed almost exclusively on cattle. Development responses and experiences are noted further below.

1.6 Desertification

Stresses on the natural resources and the environment related to drought are treated in section II.B.6. above. Desertification is a long term trend in the sub-region, drought or no drought, since it is impelled by people and livestock pressures on the environment, not by drought.

As defined by the U.N. Conference on Desertification(Mabbutt, 1984,

" desertification is the diminution or destruction of the land, ultimately leading to of desert-like conditions"

i.e. bare sand or desert pavement(pebbly surface). Since the process is essentially impelled by over-use or abusive use of natural resources in semi-arid and arid zones, the degradation of farming and pastoral livelihoods proceeds in parallel with the degradation of the land and vegetation.

Since losses or degradation of vegetation and soils are occuring virtually throughout the entire ASA subregion, desertification could be said to be happening over its entire extent. The 1:25,000,000 map of desertification hazards("Desertification Map of the World", FAO and UNESCO, 1977) clearly shows the various desertification processes to which different parts of the sub-region are subjected.

Virtually the entire Sahelian zone is subject to sand drift as is most of Botswana and portions of southwestern Zimbabwe. Run-off erosion endangers lands in many places in the higher rainfall portions of the sub-region. Most serious, because of its irreversibility, is the threat of extreme erosion leading to the formation of stony pavements and exposure of hard pans or rocks, especially in Ogaden and Somalia, but also in much of Western Sudan, E. Chad and the Ferlo of Senegal, including an extension into Mauritania.

How far desertification has gone, and how reversible it is, are poorly known, however. The different stages of desertification have not been monitored. UNEP attempted to assess the status of desertification in Africa and the rest of the world by questionnaire during 1981-83(Mabbutt, 1984).The level of response was good but the infor?mation provided was "patchy". Countries had not undertaken actual assessments of desertification. The result is largely qualitative, even though it is presented quantitatively, i.e. as percent of rangelands or croplands moderately or severely desertified. The results weren't compiled as maps.

For Africa, the responses indicated that the production potential of between 80% and 90% of the sub-region's range and farmland had been reduced by 25%, affecting the livelihoods of 11 million pastoralists and 70 million agriculturalists.

Productivity losses in farmlands, defined as moderate desertification are indistinguishable from what has elsewhere in this planning document been called land degradation due to soil loss and productivity declines.

Notably, some stages of desertification are not readily monitored -- e.g. shift in dominance to more drought tolerant range species, reduction in low brushy growth, and early stages of wind and soil erosion. Trends in seasonal biomass, monitored by NOAA for USAID since 1981, are establishing the beginnings of a baseline that if continued and enriched with ground observations could serve to remotely sense some indicators of desertification. Presently,however, the thrust of this interpretive work is aimed at predicting crop yields.

1.7 Coastal resources management

The waters off the arid coasts of East and West Africa contain rich fisheries. Seven of the eight coastal countries occurring within the subregion have shown significant increases in their average annual marine fish catch over the last decade (WRI 1986).

In East Africa, mangroves, significant both in providing nutrients to coastal waters and as nursery grounds for many commercially important fish species, cover an estimated 125,000 hectares. Major stands occur in Kenya and Tanzania, lesser stands in Somalia (UNEP 1982b). Mangrove poles have traditionally been exported for their value as construction materials in the Middle East and used locally as sources of firewood charcoal and tannin production. In recent years, Kenya has been exporting half a million poles and Tanzania a like number.

Coral reefs support artisanal fisheries in Kenya and Tanzania. Even in Somalia, where fishing is not traditional, there are over 22 cooperative societies.

The sub-region's sandy beaches support major tourist industries in Senegal and Kenya. Over 100,000 tourists take advantage of Kenya beaches annually. Kenya has established marine parks to protect coral reefs as a tourist focus.

The major coastal managemenmt problems within the subregion are:

*Over-exploitation of coastal fisheries in Mauritania and Senegal.

*Loss of mangroves forests.in both West and East Africa.

* Destruction or damage to coral reefs.

The major cause of mangrove loss in West Africa is reduced freshwater inflows during the drought. Conversion to rice fields is a lesser reason.

Top-drying and mortality of certain kinds of mangroves (e.g., tall Rhizophora trees) has created barren flats and communities of scrubby halophytes that are adapted to high salinity. This effect has been documented for the Casamance and Sine Saloum areas in Senegal and the Gambia River basin. Rice cultivation is impacting the mangrove areas of Guinea Bissau.(IUCN 1985).

The damming of river mouths to prevent intrusion of saline watger into cultivated valleys, as well as withdrawal of groundwater have added to the stress on estuaries caused by reduced freshwater inflows, particularly in Senegal and Gambia. In Gambia the proposed dam on the Gambia River is likely to reduce the existing mangrove area by 70 percent, and fish and fish culture by 30% (Mulby 1986).

There are also indications that considerable illegal harvesting of mangrove occurs in the more inaccessible areas of the sub-region.

Despite the importance and extent of East Africa's fringing reef, no estimate of total regional reef area appears to exist. Expoitation the coral reef ecosystems appears to be increasing. The effects of overfishing, blast-fishing with dynamite, and coral and shell-collecting have been reported from sites ranging the length of the reef (UNEP 1982b). Heavy fishing pressure on the reef has occurred near Tanga and Dar es Salaam in Tanzania. Die-off of fish and coral due to high sediments loads and pollution have been recorded at Malindi in Kenya, and Dar es Salaam, Tanzania, respectively. Heavy sediment loads carried from river mouths to the reefs are likely to be damaging them.(Salm and Clark 1984).

1.8 Development experiences and responses

Responses to the recent drought crisis are noted in the discussion under II.B.6(Stresses on natural resources and the environment coincident with the drought). Reviewed here are long term development actions that go beyond the amelioration of stresses. The distinction between the two is, however, not always clear. In fact a criticism of ten years' of efforts around the world to arrest desertification was the standard development thrust of most projects carried out under the banner of combating desertification(Dregne, 1984). Only 1/10th of the projects reviewed had actually been to reverse desertification; many focussed on increasing or restoring cattle herds and irrigation.

Drought and desertification have been inseparably linked in Africa since 1968, especially as regards development responses. This has caused the two problems to be addressed together in development assistance responses. However, the drought has masked or obscured the effects of long term land and vegetative degradation associated with rising livestock and human populations.

Degradation had not been monitored prior to the drought, nor has it been monitored since, except in isolated research areas. Consequently development responses to overcome the effects of the drought have focussed on restoring production, including cattle numbers, to predrought levels without regard for the fact that use intensities at traditional technologies are no longer environmentally sustainable.

All countries in the sub-region have programs to combat desertification. These programs are key elements in the national economic and social plans of the Sahel-sudanian nations, they are developed with the support of the UN Sahelian Office, and they were originally funded through the CILSS/Club du Sahel mechanism. As the drought continued the programs have served as umbrellas to garner international support for a great diversity of development assistance.

The great majority of these early development responses to assist nations suffering drought ran into serious difficulties because of a mis-appreciation of the underlying dynamic of desertification and of the great conceptual and organizational challlenges it presents to societies, including developed ones.

Among other lessons that emerge from the experiences to date is the general one that desertification is very difficult to reverse during a drought. The re-establishment of vegetative cover is simply very chancy if not impossible during a drought. A second is that restoration of production levels as a response to drought is extremely difficult if the process of degradation leading to desertification is also taking place.

Conservation of wildlife and genetic resources

Major international funding and development agencies have shown little interest in financing such park and natural areas management in this sub-region. Assistance has been dominated by the conjunction of drought and economic stagnation. Nevertheless, countries such as Senegal and Tanzania devote a respectable proportion of their buydgetary resources to conservation and natural area management.

Major non-governmental programs have concentrated in conservation activities in East Africa. West Africa particularly, in regards to wetlands conservation is receiving renewed attention particularly by IUCN and the Africa Wildlife Foundation.

Local non-governmental organizations are rare. Most notable are the Wildlife Clubs of Kenya and the Kalahari Conservation Society of Botswana.

Livestock and range management

Livestock projects have come under particular criticism within AID on the basis of in-house evaluations (see below) as well as in other donor agencies. All experience and reviews points to the need to enlarge the scope of analysis of projects so as to include all relevant factors.

In 1986 USAID was supporting the following projects related to range management and livestock:

Gambia: range ecology and management(U. of Colorado)

Lesotho: range development, as a sub-project to a land conservation and range development project(1980-87)

Mali: livestock production but no range management.

Niger: range regeneration and management(Forestry and Land Use Project, to be ended in 1987)

Somalia: rangeland development project, part of a multi-donor effort for development of the central rangelands. AID contribution is $19.2 million during 1979-1986. AID also joined the Kuwait Fund for Arab Economic Development in the development of rangelands in northern Somalia through reserve establishment, well drillling, fodder production.

Evaluations or other details on the successes of these projects were not seen.

The problems of African rangelands and the results of various development experiences in range management and livestock were very succintly reviewed by the NAS(1983) and the West German aid agency, GTZ(GTZ, 1986). Also AID's Bureau for Science and Technology reviewed in late 1985 a number of AID projects concerned with livestock and range in AFrica(various unpubished reports), the outcome of which is summarized later.

GTZ reviewed a wide range of range and livestock project interventions:

- breeding programs
- veterinary care
- marketting and processing
- stratification of livestock production
- water development
- range management(through privatization)
  - grazing blocks
  - grazing reserves
  - group ranching
  - reseeding
- forage cultivation
- animal traction
- settlement projects

Problems and setbacks beset every one of these approaches. The review concluded that "on the whole, negative experiences in livestock development projects prevail.."(p. 156)

The reasons include insufficient knowledge of tropical biology and ecosystems, insufficent knowledge of existing production systems; inappropriate or inadequate organization, communication and staff incompetence.

The report recommends greater emphasis on the development of smallholder 'tradtional' systems and less on the introduction of large-scale modern systems. Also it recommends the use of the systems approach to obtain a more methodical procedure for inter-disciplinary work in understanding, diagnosing and designing, as well as testing and extension.

The review is generally in agreement with AID in-house evaluations noted below.

AID reviews of range and livestock projects: In recent years, USAID has undertaken or commissioned a number of reviews and evaluations of AID-supported livestock and range projects. These have been undertaken independently of similar reviews for forestry projects, notwithstanding the widely recognized importance of permanent woody vegetation as browse resources in semi-arid and arid range.

In June, 1980, the Institute for Development Anthropology reported on the conclusions of a Workshop on African Pastoralism and African Livestock Development(AID, 1980):

* quantitative data on pastoral systems are inadequate.

* management of livestock development should be small scale and based on existing cultural-ecological systems.

* pastoralists' mobility helps them survive in drought crises as well as effectively exploit the range over the long term.

* subsistence rather than commerical pastoralism should be supported during droughts.

A 1982 "Livestock Development Assistance Strategy Paper" developed in the Africa Bureau lacks any mention of the above workshop or of range management except for opening up unused range resources through the provision of temporary water points. The strategy addresses integration of livestock production with cropping systems. The recommendations of the 1980 workshop were apparently passed over.

Continued difficulties with livestock projects spurred the convening by AID's Bureau for Science and Technology of an expert panel in Washington D.C. in September, 1985, to deliberate the question:

"Should AID try to promote development of sustainable extensive livestock production systems in Africa? ".

Extensive production refers to range-fed livestock only, as distinguished from those that are herded into adjacent farming regions to eat crop residues during the dry season.

The panel cautiously answered in the affirmative. The strongest recommendation concerned training so as to build a stronger in-country cadre of technical and scientific people. Training in range ecology and management, animal sciences(including wildlife), range and livestock economics, and anthropology and sociology were specified(Panel Report, Oct., 1985).

In addition, drought planning, a broader systems view of livestock/range development, and a long term view were strongly recommended. The panel noted the important role played by livestock in sustainable agricultural systems in Africa, however, made no related recommendations.

In 1986, a systems view of livestock projects is being modelled for AID in a project carried out by IIED for AID's Bureau for Science and Technology. It could be used in the future for attaining the more comprehensive, systematic attention to all aspects of livestock and range management in the African context. 500 to 600 data points in Africa have been developed; the model may be used to evaluated a livestock project in Botswana, being planned by the World Bank.

In conclusion, AID still has not identified a clear policy and direction concerning livestock and related range development in Africa.

Forestry

Evaluations and experience over the past 10-plus years indicate that much more attention must be placed on research and management of natural woodlands and associated vegetation than has been accorded up to now. It is generally recognized now that block plantations are not the answer to "deforestation", much less "desertification"(World Bank, 1985; USAID, 1984; GTZ, 1986) Also agroforestry is seen as a key element to sustainability of agrarian livelihoods in the sub-region.

Block plantations may be needed to supply urban fuelwood or charcoal, but in rural areas, other solutions, more ecologically and culturally appropriate are needed. In particular, intensification of research and development of agroforestry species and systems is needed(IUFRO resolutions from a February, 1986, meeting in Nairobi).

Lack of trained African foresters handicaps progress, and is usually identified in AID forestry projects as a constraint, and as a justification for on-the-job training and lonng term training in the USA or another country.

On-the-job training and training provided by project advisors has frequently been accorded short shrift, typically because project management difficulties eclipse this input.

The transformation of post-colonial forest services in Africa from law enforcers and forest preserve protectors, to facilitators of rural development and promoters of agroforestry and village forestry is painful but is slowly taking place. Training for these tasks is not available except in the field,on the job. No university or school teaches the needed combination of skills and subject matter, excepting the Dinderesso Forestry School in Burkina Faso(Bobo Diaoulasso).

It seems clear that semi-arid zone agroforestry and forestry training can best be provided in Africa, by Africans or foreigners with great experience. Arid zone forestry training is weak in the forestry schools of the USA(U. of Arizona) or Europe, and must eventually be developed in semi-arid Africa, along with basic and applied research, now being carried out on a very minimal level, relative to the needs.

USAID forestry assistance:

AID is currently supporting a wide range of forestry and agroforestry projects and activities in the sub-region. However, there were few new starts in FY1986.

Regional Water Development

Great importance is attached to the development of international rivers in the arid and semi-arid regions, especially the Senegal, Niger and Gambia Rivers. The Chari River, flowing into Lake Chad from headwaters in the CAR is also a lifeline for Chadians and lakeshore dwellers on the Nigerian and Niger shores.

The multi-donor sponsored AGRHYMET project executed by the World Meteorological Oganization responds to the need in the Sahelian states for better agro-climatological, hydrological and meteorological data. This regional project is headquartered in Niamey, Niger. At present AID is supporting AGRHYMET at a level of $1.4 million per year, during 1982-87.

Since these rivers arise in sub-humid uplands to the south, where a single rainy season occurs, they are subject to sharp seasonal flucuations, which predictably will be accentuated by loss of vegetative cover in the catchments in Guinea and CAR.(The same consideration applies to the Zambezi River in southern Africa).

An awareness exists of the important role of upper catchments of these rivers, but an international effort commensurate with their importance does not appear to exist.

Instead, donor assistance has focussed on planning for and development of water and land resources in the valleys of these rivers, including support for multi-state bodies such as the Senegal Basin Develoment Authority(OMVS) and the Niger Basin Authority, and the Lake Chad Basin Commission.

With regard to the management of the catchments of international rivers flowing northward into the arid and semi-arid tropical Africa, effective conceptual and technical actions at the programming and planning level are yet to be undertaken.

A possible exception is the WMO-executed AGRHYMET for CILSS.(Are Guinea and CAR included in the network?)

Groundwater development and management are of crucial importance to most parts of the region. But almost everywhere, there is a dearth of (1) information and (2) African hydrologists, geo-hydrologists and corresponding institutions.

The UNDP and various donors have helped undertake groundwater surveys, gather data and train technicians.

1.9 Preliminary agenda for assistance

Preliminary recommendations concerning conservation of genetic resources and wildlife habitats, desertification, agro-forestry, range and livestock projects, water projects, and the fuelwood crisis follow. The last item, village environmental regeneration could strategically embrace most if not all the above, and may be the key to successfully addressing the social and economic linkages in the reversal of enviornmental degradation.

<u>Conservation of species and habitats</u>

Technical assistance and institutional strengthening are key needs for more effective preservation of these resources. Plant surveys and explorations for useful varieties of fuelwood, browse and food plants should be pursued, perhaps through support to the International Board for Plant Genetic Resources.

Ways to bolster the management of existing parks and biospheric reserves, including the important wildfowl overwintering habitats in the inland deltas must be found.

There is an immediate need to identify critical areas within the subregion where protection is most needed and provide logistical and technical support for their continuance through PVO/NGO organizations. National governments would take the lead. Both Niger and Senegal are apportune candidates.

Understanding desertification

The reversibility of the desertification process has been shown to be possible, and to occur at a surprisingly fast pace in the places where it has been observed(Mauritania, NAS,1983 ; Niger, Tropsoils Communique No. 22, 1984). This resilience of semi-arid and arid vegetation is great , but varies according to soils conditions.

Basic and applied research on the ecological dynamics of desertification and its reversal is badly needed and a modest research investment by AID, perhaps as part of a multi-donor supported research effort, should be of high priority.

Monitoring of degradation leading to desertification

Development of reliable indicators of degradation, including population and landuse changes that create a context for it, is yet to be done for this sub-region. Indicators are needed that an be observed remotely and measured with a minimum of ground checking. The previously mentioned research could provide some of the indicators.

Assuming the development of appropriate indicators, AID could support alone or with other donors and the U N periodic surveys of these indicators in the sub-region.

A preparatory step for this effort should be a thorough technical review of work on behalf of UNEP and undertaken by FAO's Land and Water Division, involving the multi-factorial computerize analysis of soils and climatic data, for estimating desertification and degradation hazards.

Lastly, various ecological thresholds in the degradation ofvegetative formation and/or site degradation should be identified in different rainfall belts in the sub-region.

Range resources and livestock assistance

Admitted failures and ignorance characterize assistance efforts in these endeavours. More knowledge is needed, obviously, in order to more effectively approach the development problems posed. A commitment to or assignation of priority to range and livestock management in light of our relative ignorance would be unwise. AID's S&T/FENR office understands this and has initiated a process of exploration of options and of the state of knowledge. These efforts need sharper focus and a clearer articulation of their purpose.

Further actions can be suggested:

* The dynamic systems model for range management being developed by IIED should be field tested for conceptual appropriateness as well as feasibility from the standpoint of data inputs. Field testing candidates could include the UNESCO Integrated Project for Arid Lands in Kenya and the Bakel Livestock Project in Senegal, now run by FAO but started by AID. Von Trapp's range ecology monitoring results for Senegal's Ferlo could also be employed; this is an FAO/UNEP effort.

* AID should commission a survey of evaluations carried out by multi-lateral and bilateral development agencies of range and livestock projects, to complement its own rather limited and largely negative experiences in this area.

* Currently supported research at ICRISAT/Sahel and SAFGRAD should include livestock in the research agenda, with the aim of improving this component of the farming and livelihood system in this sub-region.

Agroforestry and forestry

Agro-forestry:

Multiple-purpose agro-forestry species, especially the *Acacia albida*, in and around cropped areas are a key to the sustainability of dryland agrarian systems in the sub-region.

Both research and applications of agroforestry are needed.A research agenda for agro-forestry in the sub-region has already been discussed and prioritized at a workshop held in Nairobi, in January, 1986, under the auspices of the International Union of Forestry Research Organizations.

Thirty-five research proposals were presented, and discussed. Country participants strongly supported training, extension and data dissemination networks. African and donor participants agreed on prioritizing:

* natural regeneration in silvopastoral systems

* genetic improvement of multi-purpose trees

* applied agroforestry research, especially concerning
  - browse species
  - the tree/agriculture interface
  - windbreaks
  - fuelwood
  - food from woody plants

* AID should chose research topics it wishes to support and take appropriate actions to finance them.

* PL 480 accounts should be used for agroforestry promotion in as extensive a geographic area as possible. AID pledges to the WFP could seek to stimulate the planting of agroforfestry species.

Forestry:

Training and research in arid zone forestry must be fostered, and a capability created in French-speaking and English speaking portions.

<u>Water resources</u>

The needs for effective water resources management at all levels in this sub-region can only increase as water development proceeds, with or without the assistance of different donors. Poor water management, or its neglect, could have disastrous implications for settlements and irrigation systems. Long term, conssistent support by AID for certain facets of water management is recommended, especially: data collection, surveys, data management and communication, and training.

Several actions can be recommended.

* AID support to AGRHYMET should continue for as many years as may be needed, perhaps into the 90's.

* The plan being designed by World Bank to up-grade hydrological and meteorological services in Africa should be reviewed as a possible vehicle for AID support in these important field outside the Sahel.

* Ways to monitor and manage shallow aquifers, seasonally re-charged by rainfall, should be devised and instituted, where these are tapped for rural potable water and nurseries. (Review of this recommendation by WASH project staff is needed.)

* Long term training. Training is virtually an automatic add-on to AID water development projects, but its impacts aren't evaluated nor do the long term students return in time to participate in the project that financed their scholarships. Rather than have training linked to development projects which "discover" a lack of trained personnel, training needs for water resources development and management should be assessed from the standpoint of long term trends, master plans for water development and related institutional and survey needs.

Resolve fuel crisis

The success of efforts to stabilize and achieve sustainable agriculture in the sub-region ultimately hinge on the resolution of the rural and urban fuel crisis.

The resolution of the fuel crisis in this part of Africa must be viewed as one of several strategic goals in the reversal of agricutural land degradation. To date the crisis has been defined mainly in terms of its impact loss of vegetative cover.

The fuelwood problem and its relationship to agricultural productivity, livestock raising, and desertification is a demonstration of the ecological rationale that underlies rural livelihood systems, and the use of this rationale to analyze "inter-sectoral linkages".

Since only partial not definitive solutions have been devised, a bold approach is needed. Tree planting is not adequate. Improved stoves help but don't solve the deficit. New and alternative sources of energy and greater energy conservation are imperative.

Recommendation: The WRI/World Bank/UNDP Country Investment Profiles, in Tropical Forests: a Call for Action include specific project suggestions on fuelwood production, substitutes, use efficiency, and conservation for every African country with acute scarcities or deficits of fuelwood. AID should review the recommendations and consider supporting them in the ASA sub-region.

Village level regeneration actions

Actions at the village level in the sub-region are the key to the twin goals of (1) arresting degradation and regenerating the land and vegetative resources, and (2) increasing food and fuel self sufficiency.

At this moment in time strong village social organization and the tradition of group work stand in sharp contrast to weak or absent governmental rural development services concerned with resource management. However, a number of successful PVO projects have revealed how by working with the entire livelihood system at the village level, social, economic and ecological appropriateness of development interventions can be achieved. Given appropriate techniques and support villages can mobilize the workers needed for reforestation and soil conservation, and moreover, undertake these on their own initiative (Harrison, 1986).

More sophisticated work will eventually be needed, but these simple starts set the stage for such future work.

AID should seek to support the mobilization of villages in the region in self-help measures to arrest degradation and restore productivity:

* through grants to PVO's in the region.

* through special PL 480 village regeneration accounts

* through specifically earmarked accounts in WFP.

* through an expanded Peace Corps effort.

* by supporting IUCN's village eco-development initiative, which is a key element in the proposed long-term strategy for environmental rehabilitation of the Sahel. Support could be direct as well as endorsement, so as to encourage othjer OECD donors.

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3.0 Sub-humid tropical uplands

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3.1 Description

The prolonged drought that started in the Sahel and extended to the rest of the semi-arid sub-region in eastern and southern Africa revealed how important the adjacent sub-humid uplands are for the neighboring semi-arid tropics, especially for survival of cattle. In the Sahel many, though not all, nomadic pastoralists moved from their usual dry-season ranges in the semi-arid regions into the sub-humid regions in search of green forage, crossing political as well as cultural boundaries.

No major urban centers are found in the sub-region, owing to its situation in upland areas that span watersheds and national boundaries, far from the major river or coastal ports. However, its rural population is dense, especially in East Africa and south of the equator, where concentrations of over 100 per square kilometer are not unusual. Exceptions are the rather sparsely populated CAR, southern Sudan,and southern Guinea.

There is a single rainy season of 6 to 9 months duration. Yearly rainfall is between 1000 and 1800 mm approximately. North of the Equator, temperatures are 24 to 28 degrees C. on average, and the Harmattan wind adds heat and aridity to the dry season, prior to the summer rains, making fire control difficult. South of the equator, the higher elevations lower the average temperatures to around 20 degrees C.

<u>Soils and vegetation</u>

The geology, geomorphology and, consequently, the soils of the sub-region are varied, being formed over Pleistocene clays, pre-Cambrian rocks, and in places sedimentary rocks. Elevations are not normally greater than 300 meters above sea level north of the Equator, but increase to between 900 and 1100 meters north of the Kalahari basin on the Zambezi plateaux.

Almost every major soil group found in the African tropics is found in this sub-region, however, Alfisols and Oxisols are most widespread. Alfisols are the more typical of sub-humid climates, being coarse to medium textured on the surface, clayey at depth, and moderately fertile(over 50% base saturation). Their water holding capacity is low, however.

The natural vegetation corresponding to the sub-region has been described by White(1983),and represents two distinct major groupings, the Zambezian and the Sudanian, each with a distinctive flora. Both are open woodlands. Also a narrow strip of the Zanzibar-Inhambane "regional mosaic" containing edemic flora occurs on the coastal lowlands of Tanzania and Mozambique.

The dominant natural vegetation in the southern arm of the sub-region is the Zambesian miombo woodland occuring on leached, acid, shallow or stony soils,often with lateritic or gley horizons. The dominant trees do not exceed 20 meters and are characteristically flat-topped, with short boles. There are few undisturbed remnants,however.

Shifting cultivation has everywhere altered this vegetative formation. North of the equator, where there is a gradual transition to aridity not complicated by major ranges of mountains, the vegetation of the sub-region is classified as Sudanian woodland, containing many species that extend into the semi-arid portion of the adjoining Sahelo-sudanian zone. In fact, the UNESCO classification of Sudanian woodland extends into the agro-ecological growing zone of 150 days and less(White, 1983), i.e. well into agronomically defined semi-arid tropics.

In the Fouta Djalon highlands, where the Gambia and Senegal rivers arise, mists are frequent and ferns and epiphytes plentiful,especially at 800 to 1000 meters above sea level.(White, 1983, p. 82). Trees are mostly the same species as those found at lower elevations on the coast, and are dominated by Parinari sp. Only remnants surviving in steep ravines have survived fires, however. Larrger blocks have persisted in the wetter highlands except where mining operations have destroyed them.

The rate of species endemism within the subregion is generally low in comparison with other sub-regions. The southern portion of the subregion, including the whole of Zambia, Malawi and Zimbabwe, supports the highest levels of endemic plants and, particularly in the Lake Victoria area, supports moderate

levels of endemic birds (15%) (IUCN ___). Mammal endemism is low, however, because of the vegetative complexity, transitional nature and widespread occurence of the subregion, it is extremely rich in variety and abundance of both plants and animals. This includes many of the wildlife species (elephant, buffalo, etc.) commonly associated with Africa.

Within the subregion, both wild game and plants play an important role in the diets of the people. In Zambia, game meat accounts for over 13% of total annual protein consumption (Presscott-Allen 19). In Zimbabwe, game ranching, including crocodile farms, has become an increasingly important form of land use (Child and Nduku 1985). Here there is special emphasis to return both products (meat, hides, etc.) and revenue from the wildlife resources to local rural communities (ibid.).

This subregion also contains genetic potential for improved varieties of sorghum and millet. IITA has targeted the CAR, Mozambique and Zimbabwe for cowpea surveys to locate potentially valuable varieties (Hawkes 1985).

The herbaceous swamps bordering the lakes of this subregion are very productive ecological systems. These include lakes Victoria, Bangweulu (Zambia),Mwena (Zaire/Zambia)m Naivasha (Kenya) and Chilwa (Malawi/Mozambique) (Maltby 1986). Of the major seasonal floodplains within the subregion, the Kafue Flats of Zambia are most important.

Coastal resources

Nearly half the population of Mozambique lives at or near the coast. It has the second highest levels of marine fish landings and per capita fish consumption on the East African coast excluding offshore island nations (UNEP 1982). Subsistence and commercial prawn fisheries provide an important export item and source of foreign exchange, second highest in the nation.

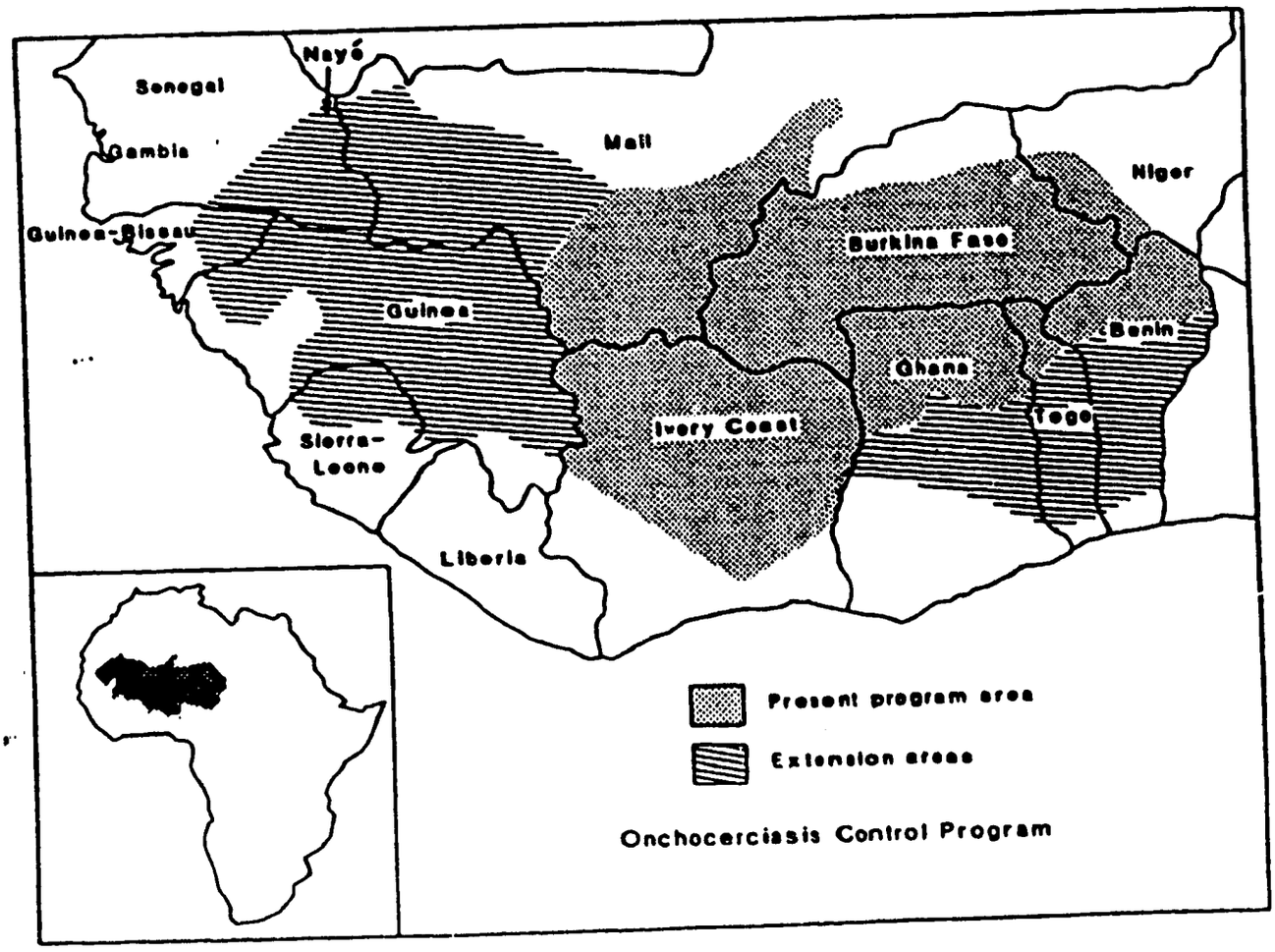
The 500,000 hectares of mangrove forests support the prawn industry and are a valuable source of fuelwood and other wood products. Coastal tourist industries have the potential to become a major economic factor as it was in the early 1970's when the bulk of the 500,000 tourists were attracted to the coral sand beaches (UNEP 1982b).

3.2 Natural resources management issues

Fragile or easily eroded or degraded soils(for instance with lateritic layers at depth) are a principal management problem in the sub-region. However, the climate favors a diversity of food crops. In fact, were it not for sleeping sickness in cattle and humans, and onchocercaiasis(river blindness), this sub-region would be the most habitable lower elevation environment in Africa.

Trypanosomiasis is found on the humid side of 150-day growing season, that is, throughout the sub-region.

Both diseases are transmitted by flies whose habitat is in and around water courses and their riparian vegetation. A long term multi-donor project is underway to erradicate the Simulium fly vector of river blindness, but a single solution has not yet been found for Trypanosomiasis. Onchocercaiasis does not affect the southern extent of this sub-region however.



The dry season in this subregion is sufficiently long to make moisture stress an effective control on weeds...with help from fires. Rainfall as well as temperature and length of growing season are optimal or nearly so for almost every food crop: sorghum, yam, maize, soybean, phaseoulus bean, and, at the drier margin, cotton. At the humid margin cassava is well suited.

A quantitative profile of landuses in the sub-region is not possible because of its border-spanning character. National level staisitcs can't be used. Only Malawi is found entirely within the sub-region. It embraces most of the Guinea and the Central African Republic, and much of Angola and Zambia, but only one half or less of Sierra Leone, Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, Chad, Sudan, Kenya, Tanzania, Zaire, and Zimbabwe. This circumstance also renders difficult the use of secondary information sources for discerning resource management issues.

There is no threat of desertification in this climate, according to a UNEP assessment(UNEP's Desertification Map of the World). Yet, dense rural populations, a predominance of shifting cultivation of food crops, and generally rolling rather than flat topography, combine to threaten the soils and vegetative resources in this sub-region. Only in the CAR, Guinea Bissau, southern Sudan, and sparsely settled portions of Angola and Zambia is are fuelwood supplies in the sub-humid belt adequate for the forseeable future. Elsewhere there is a growing crisis due to insufficient or dwindling supplies of fuelwood. The analysis in the table below compared the sub-region's extent with FAO's appraisal of fuelwood scarcities at different levels in Africa.

Table . Fuelwood situation in the Sub-humid tropical uplands. (Source: FAO, 1981)

over-cutting now	over-cutting by year 2000
Guinea	Mali
Nigeria	Ivory Coast
Cameroon	Ghana
W. Kenya	Togo
Angola	Benin
Zambia	Mozambique
Zaire	
Malawi	

Unlike the fuelwood-poor semi-arid zone, however, rainfall is sufficient to justify effort to plant and maintain woodlots, shelterbelts, and commercial plantations, as well as multiple purpose agroforestry species.

The more abundant vegetative cover in the sub-region becomes a potential danger in the dry season. Fires for clearing or for ridding rangeland of dry growth to encourage re-sprouting of new growth may get out of control.

Seasonal migrations by nomadic herders from semi-arid regions of West Africa during droughts is a major problem, especially due to fires set by herders.

Fires not only destroy regeneration of trees, they also speed the process of soil degradation in farmed areas where fallowing is still practiced. Fires set by Peul herders in Oyo State, Nigeria, southwest of Ibadan, for example, are considered to be a major factor in the reduction of organic matter, humus and phosphorus in fallowed soils. Moreover, a hard, pebble-strewn surface had evolved after repeated burnings. Consequently, 20-year-old fallows had poorer soils than 5 and 10-year old fallows(Areola, 1980).

The principal catchments of many West African rivers are located in the uplands and plateaus of this sub-region, e.g. the Gambia, Senegal and Niger rivers in Guinea, the Bandama River, in the Ivory Coast, the Volta River in Ghana, and the Chari River which flows northward into Lake Chad.

Their sharply seasonal flows, resulting from the seasonality of rainfall, could become an even greater management problem for downstream users if they were accentuated by vegetative degradation and erosion in the major catchment areas. Present and future dam and irrigation developments on these rivers are dependent upon maximum regulation of the quantity and quality of flow from tributary streams in the upper catchments. In practice this will mean that water- and soil-conserving agricultural, forestry and grazing landuses must be devised and diffused in these catchments. Critical catchments(very steep and humid) should be conserved under natural vegetation.

Preservation of representative portions of the various plant formations and habitats found in this sub-humid belt is needed. especially given the population pressures.

Mozambique's coastal resources need improved management Of immediate concern is the integration of conservation and development for Inhaca island, a unique ecosystem of the Indian Ocean threatened by conflicting land use (Salm and Clark 1984).

The nature of the coastline facilitates the deposition and longshore transport of large volumes of riverine sedimant. This has permitted establishment of extensive regions of mangrove forest. Fisheries officials are concerned about dams adversely affecting the Zambesi delta area through disruption of saline balances and delta building. Both would adversely affect the marginal agricultural areas along the river and the primary nursery grounds for shrimp stock in the Bight of Sofala.

The government of Mozambique has proposed through IUCN and UNEP to undertake a major effort in coastal zone planning to address these major areas of concern.

3.3 Development assistance in the sub-region

AID.

Only Malawi and the CAR are entirely within this sub-region.In the CAR AID is supporting an inland fisheries program. In Malawi,(to be completed).

Elsewhere the description of AID projects is not sufficiently precise to determine their possible location within the sub-region.

In Zimbabwe, AID has provided financial support for a national conservation strategy workshop as well as mobile extension educational programs on natural resources management.

In Mozambique, AID supported a candidate to a recent international training activity for marine protected areas.

Other donors

The region's magnificent wildlife attractions have generated considerable assistance.

- FAO/UNEP has actively worked for the *in situ* conservation of forest genetic resources in Zambia assisting in establishment of two botanizal reserves (FAO 19).

- IUCN has been active in a number of countries both in dealing with national strategies as in Zambia, species specific action plans as with elephants and rhinos and in collaboration with WWF-US in the Luangwa Valley.

- WWF-US is currently considering increasing its activities in Zambia and Malawi using the WWF/AID Wildlands and Human Needs program to integrate protected area management objectives with development objectives of the surrounding populated lands. The Luangwa Valley in Zambia is likely to be one of the several program sites. Lake Malawi is likely to be another.

- WWF-US is also active in park management and anti-poaching activity support particularly in Zambia, a country of critical importance; Lake Malawi; the Central African Republic, which is one of the last major faunal reserves in Africa and under severe poaching pressure, and Tanzania.

- AWF is primarily involved with conservation education activities in Tanzania. Most notable of their efforts is their support for the Colleges of African Wildlife Management at Mweka, Tanzania.

- FAO/UNDP has funded several wildlife/protected area management projects within the subregion including projects in Angola, Burkina Faso, the Central AFrican Republic, Uganda, Mozambique and Zimbabwe. The various projects ranged from anti-poaching assistance (Uganda) to wildlife products marketing (Mozambique, Zimbabwe) (FAO 1985)

3.4 Preliminary agenda

North of the equator as well as south, the sub-humid upland belt spans many political boundaries. Consequently, it would be difficult to utilize it for organization and administra-tion of resources management. It does represent a useful focus for research, however, given its high agricultural potential. Also population pressures on the land and fuelwood resources in the adjacent semi-arid zone will inevitably lead to migrations into this zone, and a foreseeable problem of overall environmental degradation, unless sustainable food and fuel-producing systems are developed for population densities higher than presently exist.

<u>Agricultural research</u> AID should consider expanding the geographic scope of it support for ICRISAT/Sahel to the adjacent sub-humid zone. The crops are much the same: maize, sorghum, millet grow best in this climate. Soils, pest and weed management present different problems, however. Also many more agro-forestry possibilities exist.

(The CAR incidentally is within this sub-region but is listed in the AID Agricultural Research Plan as a humid equatorial lowland nation.)

Forestry. Forestry has good potential in this zone also but can't be seen as a priority, unless to resolve fuelwood shortages. Commercial plantations have good potential given availability of good soils. Natural forest management in important watershed areas need coordinated donor and African actions.
Research on trypano-tolerant cattle could be supported.

Inventories Most importantly, natural resources inventories and assessments should be carried out for this sub-region, prior to major programs of use intensification, or change, for instance as a result of elimination of the black fly vector of river blindness, or of the tse tse fly. The fragility of some of the sub-region's soils could lead to serious degradation under poor management.

Biological resources Support for biological diversity programs within the subregion should focus on support for plant genetics surveys, integration of protected area management with national development, and institutional strengthening including support for university and international training institutions.

Game management Further support for NGO/PVO projects is needed to build on past experiences. This would include support for game ranching efforts in Zimbabwe and the transfer of ranching technologies developed to other parts of the subregion, most notiably West Africa where chances of success are greatest. Wildland and human needs projects should continue to be supported particularly in critical conservation areas.

The management of Mozambique's coastal resources will require some outside assistance in planning, which has been requested.
Protected Area Management - Several countries within the subregion have specifically requested support for park management activities. Based on the need and importance donor groups/PVO/NGO communities need to work with national agencies to identify subregional priorities and support park management programs. Park "W", and protected areas in Zambia and the Central African Republic are potential candidates for support.

Lake and Wetland Management Lake Victoria has been identified as a priority concern; so has Lake Malawi and the Kafue Ilats of Zambia. On-going donor group/PVO/NGO efforts to maintain their biological uniqueness and productivity needs continued support.

Regional/National Planning - Because several of the important biological resources are shared by several nations (e.g. Lake Victoria, Zambezi River) activities related to their conservation need to be coordinated through policy dialogue and the setting of common objectives. At the national level, comprehensive conservation strategies are being developed or are planned. Support for these efforts are needed.

Training and Educational Institutions - the subregion has several educational institutions which are important for technical training in biological resources particularly in Zimbabwe, Mozambeque and Tanzania. Mweka College being the best known. Long term biological and natural resource programs within the subregion and Africa-wide will require continued donor support for their programs and activities. Much of this can be done through NGO/PVO organizational funding and matching grants.

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3.0 African Highlands

This is the most densely populated sub-region. The African highlands require an increased and sustained effort to arrest soil erosion and related productivity declines. The situation in the Ethiopian highlands which harbor 22 million people is particularly critical. Much of Rwanda, Burundi, Swaziland and Lesotho are highlands FAO reckons that all of the sub-region is over-populated at present levels of agricultural production technology. Progress achieved to date in erosion control and the design of stable farming systems will have to be repeated for the many discrete ecological situations in the Highlands sub-region at a rapid pace.

3.1 Description

As defined agro-ecologically the African highlands lie above the 1500 meter contour. However, uplifted areas of Africa form the Great African Plateau, which commences at approximately the 900 meter contour. The Plateau is bowlshaped with its rim higher than the interior (See Map).

In southern Africa, the edge of the plateau is marked by the Great Escarpment rising to its highest in the Darkensburg mountains. To the west, the plateau is bordered by the Angolan mountains and the Aus highlands which seperate the coastal Namib desert from the Kalahari desert on the plateau (MacKinnon 1986).

Between the Angolan highlands and the Great Escarpment, the plateau forms a wide, rather flat bowl, the watershed for the Limpopo, Zambesi, Orange and Cubango rivers. At the northern end of the plateau, the terrain is dominated by the Great African Rift Valley. There is a discontinuity in the plateau between the rugged Ethiopian highlands and the East African highlands linked by low hills on either side of lake Turkana (Rudolf) in the floor of the Rift. Here the Great Rift divides into eastern and western sectors and the wide lake Victoria occupies the basin between, at an altitude of 1130 meters (MacKinnon 1986).

The African highlands represent an exceptional agroclimatic zone -- equatorial yet temperate. The nearness to the equator is counter-balanced by the elevation of the land, resulting in

temperate conditions, and at higher elevations cold, alpine climates. Average temperature in the highlands varies between 16 and 20°C and in the mountains between 10 and 16°C.

The highlands ecosystems that are free from diseases endemic in the neighbouring lowlands, such as malaria and in places have moderately to highly fertile soils. As a consequence they are very densely populated. Within the past decade, intensification of cropping has been increasing rapidly. In some places there is little fallow land or grazing land left, and farmers are keeping small ruminants and stall fed cattle. Also agriculture has been encroaching into hitherto uncleared steep forest land leading to denudation of this valuable resource and soil erosion. The extremes of temperature and the occurence of frost are the only determinants of the upper limits of cultivation.

Closed forests formerly covered wide areas of both the Ethiopian and the East African Highlands. The are a recognized center of endemic flora, including among others, the wild relative of Coffea arabica.

The higher elevations support distinct conifer and broadleaved vegetation types, although mostly in a degraded condition. The main conifer species being Juniperus procera and the main broadleaved species bing Podocarpus gracilior, associated with Pygium sp., Olea sp., Hagenia sp., Cussonia sp., Celtis sp., and Polyscias sp. (FAO 1981).

The mountain steppes at altitudes 3500 to 4500 meters are formed by a continuous grass blanket and scattered shrubs of Erica arborea and Lobelia sp. (FAO 1981).

Evergreen rain forests are found only on the seaward side of Mt. Cameroon which receives some 4,000 mm of rainfall per year and along a narrow equatorial belt with rainfall from 2,000 and 2,500 mm annually.

The African highlands serve a vital function in protecting watersheds and water supplies. They also protect some of the most spectacular and interesting fauna and flora -- mountain gorillas, golden moles, giant alpine plants, colorful Protea and most beautiful mountains -- Ruwinzori, Kilimanjaro and Mt. Kenya. They are major tourism attractions. Visitors to the mountain gorillas in the Parc des Volcans in Rwanda bring over $6 million annually.

The subregion shows an extremely high rate of endemism in its plant (75%) and bird species (65%). The highlands also support unique mammal species, most famous being the mountain gorilla

in Rwanda. The Ethiopian highland was an early center of food production and continues to be of high value for genetic sources for coffee, millet and sorghum production (Hawkes 1985). Due to their unique biological richness, the likelihood that these regions were Pleistocene refugia, and the severe and increasing human population pressures being placed on them, they constitute the second greatest priority for biological and genetic diversity in AFrica exceeded only by Madagascar.

Of the very many isolated highland and montane forests scattered throughout eastern Africa, those of greatest importance in terms of biological diversity and endemism are the western rift valley, the eastern arc mountains of Tanzania, and the Ethiopian Highlands. Mt. Mulanje in Malawi is also important for plants and birds.

Agricultural land use is diverse and differs according to altitude and slope. Bananas, sorghum, and yams are cultivated at lower, warmer altitudes (1,400 - 2,000 M.), giving way to maize, potatoes, peas, and wheat at higher altitudes (2,000 - 3,000 M.). Coffee, tea and pyrethrum are important cash crops. Above 3000 meters, cold temperatures, steep terrain, shallow soils and in places extreme humidity have limited cultivation.in the past, but are increasingly being cleared, exposing shallow soils to severe erosion.

Traditional farming systems and methods of pasture and tree management are ecologically adapted, and can display considerable sophistication. New World crops, such as potatoes, yams and maize, have extended the upper limits of habitability and have been integrated into the older systems. Although traditional systems are unravelling because of population pressures, their best ecological features can be retained and be blended with modern innovations.

3.2 Resource Management Issues

Population pressures on land and vegetative resources define the principal resource management issue: over-exploitation of soils, pastures and forests and clearing of lands too steep for farming. Population densities varying from 75 to 400 persons/sq.km and livestock numbers of 75 head/sq.km are a common feature (Jones & Egli 1984).

Inaccessibility makes central governmental management difficult. In the Ethiopian highlands and the highlands of Rwanda, Burundi and parts of Zaire, poor communications with the outside world, partly the result of ruggedness of the terrain, are one of the

major bottlenecks in development. These areas are among the most removed from the world markets. High transport costs severely limit the regions trade. Even today, transport to and from these highlands is almost invariably by head portage.

Because of the scattered island-like nature of the highlands, the seriousness of the impact on biological and genetic diversity is disproportionately great. With only 4.5% of the sub-region in any type of protective status, relic communities are often too small to sustain endemic populations. The problem is compounded by the difficulty in implementation of a cohesive program for such a scattered subregion.

West African Montane Forests are receiving increased recognition for their significance (IUCN 1979), especially neighboring peaks of Mt. Nimba on the Liberia-Ivory Coast-Guinea border, the Fouta Djallon in Guinea and Mt. Loma in Sierra Leone. In Nigeria, the Oban Hills and Obadu Plateau are important for plants, birds and primates(These are somewhat lower than 1500 meters and are too small for depiction on the sub-regional map).

In Cameroon, Mt. Oku is the most biologically unique and heavily threatened area of mountain forests. Also, in Cameroon, Mt. Cameroon, an important Pleistocene refugium, has an estimated 45 endemic plant species. It is also a major water catchment, the lower southern slopes receiving the highest rainfall in Africa. The mountain is unprotected at present and its forests are being cut by shifting cultivators.

The highlands have high energy requirements both for cooking and heating. Average consumption of fuelwood is . All of the highlands in East Africa are experiencing fuelwood shortages locally or regionally and cutting at rates are greater than wood growth. The situation in Ethiopia, whose highlands are drier than elsewhere is particularly critical, and its solution is integral to the stabilization the land base.

Colonial and post colonial governments in East Africa have attempted to arrest soil erosion with varying success. Kenya appears to have had the greatest success but much land remains to be treated. Control techniques are not always appropriate for soils and cropping systems.

3.3 Donor Assistance:

Inaccessibility, diversity of local environments, and remoteness of these areas complicates donor assistance which is considerable and varied. Most generalizations about assistance are not useful. Assistance has been provided largely for

agricultural production, some for soil conservation and watershed rehabilitation and the least amount for forestry and range rehabilitation and management. Non governmental organizations, both national and international are active in every aspect of development and their scale of operation is well suited to the needs of the sub-region.

Much attention has focussed on erosion in the densely populated, East African highlands from Ethiopia -- where the World Food Programme has undertaken the most massive watershed treatment efforts in the Africa-- to the sub-tropical highlands of Lesotho and Swaziland in southern Africa.

A special research effort to assess the soil conservation efforts in Ethiopia is also underway, with collaboration and assistance from the United Nations University and the University of Berne, Switzerland (Brown and Wolfe, 1985). This type of assessment is much needed and has been lacking. Actual measures of soil erosion rates and of soil formation rates are also lacking except on a few experimental plots. AID has sponsored some of the only recent field surveys of erosion rates in 1984-85 in Kenya and Rwanda, under a sub-project activity of the Environmental Training and Management in Africa project, that has been completed.

In Kenya a presidential level Commission on Soil Conservation and Afforestation was set up in 1980 to coordinate and stimulate efforts at local and higher levels. However, it is not an executive agency. Soil conservation through terracing had resumed in 1974, after independence, with Swedish aid and considerable, steady progress has been made(Harrison, 1986). Large areas remain without erosion control treatment, however. Interestingly, the heavy handed policy of enforced terracing instituted by the colonial administration in Kenya was a such an irritant that rural people were biased against terracing for some years following independence.

Kenyan non-governmental organizations have been most effective in promoting and extending soil conservation, energy conserving stoves, and agroforestry practices.

The colonial rule of Rwanda under the Belgians pursued similar oblligatory soil erosion control policies, namely the construction of infiltration ditches on cultivated hillsides, stabilized with plantings of a perennial grass, Pennisetum sp.. The present government continues this practice, setting quotas of so many kilometers per year of infiltration ditches in each prefecture. Of course, it is the farming population that builds the ditches.

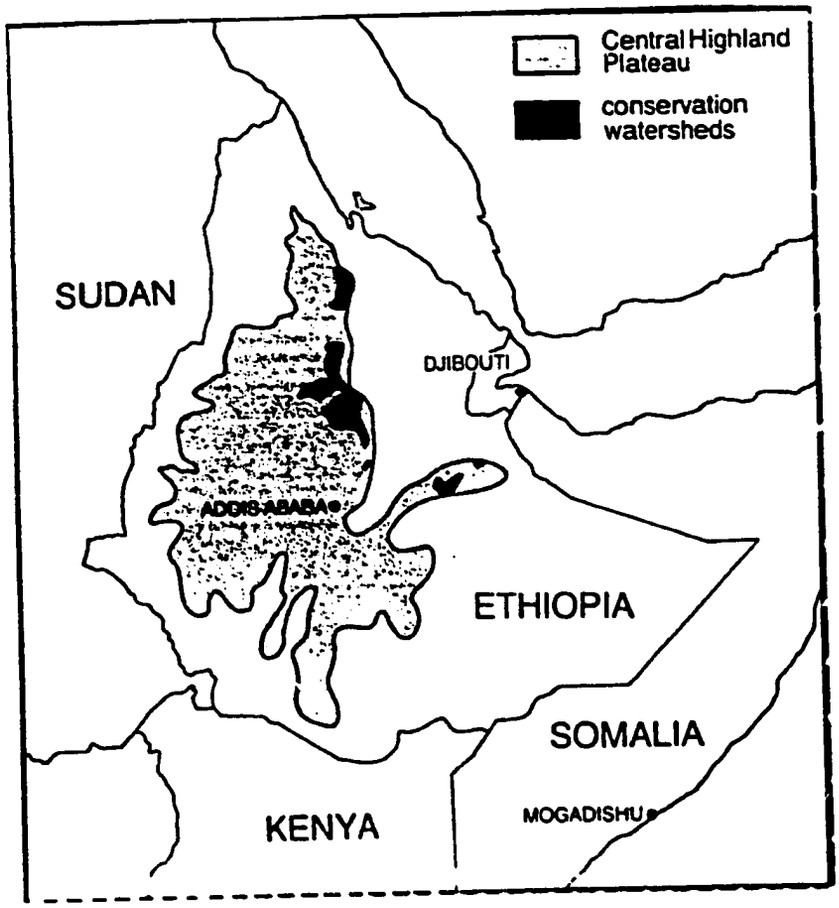

Fig. Conservation Watersheds in Ethiopia

The diversity of donor assisted projects in Rwanda is illustrative of specific actions:

*A "shelterbelt" plantation around the Gishwati National Forest, funded by the World Bank(being planned)

* Belgians are undertaking 1:25,000 topographic mapping,and soils mapping.

* Switzerland is funding technical assistance in forestry.

* GTZ recently ended a 7-year project to develop agroforestry systems in the highlands(Projet agro-pastoral Nyabisindu), which is now being evaluated..

* WWF supports research on mountain gorillas in the Parc des Volcans.

* CARE is supporting village reforestation and watershed forestation.

* USAID is supporting agroforestry activities carried out as a part of the Energy Initiatives for Africa project, based at Nairobi, Kenya.

* USAID is also supporting a prefectural assessments of natural resources and environmental management problems in the environs of the Parc des Volcans, home of the Mountain Gorilla, designed to relieve encroachment and poaching pressures on the park as well as arrest environmental degradation..

The international non-governmental conservation community has been quite active in the sub-region. Historically, the Eastern African Highland and Montane forests have received the most attention. The most notable effort has been the Mountain Gorilla Project in Rwanda. IUCN, WWF and AWF. all consider the entire sub-region as being of immediate concern.

Official assistance agencies have been slow to address conservation and diversity issues. AID has financed efforts in Burundi and Rwanda to create stable buffer zones near important parks. However, neither the FAO tropical forestry action plan (1985) nor the WRI (1985) companion document list any highland forests as priority areas. Nevertheless, the World Bank (1986) views the forest ecosystems of Ethiopia, Rwanda and Cameroon as being threatened.

3.3 Preliminary agenda

The arresting of soil erosion in the East African and Southern African(Lesotho and Swaziland) highlands is of greatest priority. It is a pre-condition for elevating food production, resolving rural fuel and construction wood problems, and the conservation of remnant forests and existing parks.

Soil erosion control programs to be successful must be merged with agricultural production projects and policies, in order to supply the incentive of increased marketable or consumable yields. Possible actions specific to soils that are needed can be listed.

In the areas of research and planning:

* soils surveys, including land capability assessments at several levels of technology(traditional and modified traditional and high input)

* soil erosion surveys and monitoring

* research on rates of soil formation(natural regeneration)

* erosion control research for different soils, cropping systems and socio-economic levels.

* economics of soil erosion control

* crop and tree/perennials management for erosion control.

Agricultural research and development:

* address total livelihood system where farms are too small for significant surplus -- i.e. low input technologies for resource poor farmers. Food, fuel, water and construction needs are paramount, and research must somehow integrate advances in crop improvements, crop and soil husbandry, animal improvements and husbandry, forestry and agroforestry, as well as soils per se. Clearly a sociological overview must guide the search for technological innovations.

* priority to research in support of reversing degradation in better climatic and soils situations.

Soil conservation, forestation and watershed treatement:

* expand the work done through the WFP in areas of food shortages, i.e. in Ethiopia.

* perform multi-donor soil conservation needs assessments in the East AFrican highlands.

* undertake multi-donor, regional watershed management needs assessments in West Africa.

Conservation of wildlands and biological resources.

* undertake management oriented surveys and research of important preserves of biological diversity.

* strengthen indigenous insitutions charged with protection and conservation.

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4.0 Humid Coastal Lowlands

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4.1 Description

The nations which share this high rainfall, densely settled strip of West Africa, are:

Guinea Bissau
Guinea
Sierra Leone
Liberia
Ivory Coast
Ghana
Nigeria

The maximum width of this coastal belt is approximately 350 km, and only Liberia is completely within the sub-region. Sierra Leone is almost entirely wihin it, but the other states extend northward into the contiguous sub-humid tropical uplands. Nigeria continues into the semi-arid tropics.

The region is one of growing cities; this portion of West Africa is more urbanized than interior states. The coastal cities have attracted migrants from landlocked countries in the drought-stricken Sahel as well as their own rural hinterlands of the respective nation states.

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Percent urban population in coastal West Africa

	1960	1985
Gambia	12	21
Guinea Bissau	14	27
Guinea	10	22
Sierra Leone	13	28
Liberia	19	40
Ivory Coast	19	42
Ghana	23	40
Togo	10	20
Nigeria	13	23

Source: WRI, 1986, Table 3.1

Climate

Maximum precipitation values range from 4349 mm per year at Conakry, Guinea, to 3874 mm per year at Monrovia. There is a pronounced dry season of two months and, in places, more(e.g.Guinea). Yearly values of around 2000 mm or less are more representative of the subregion, e.g. 2040 mm at Abidjan and 1834 mm at Lagos, near the so-called low rainfall "Dahomey Gap". Atmospheric humidity is high along the coasts, however.

The sub-region has a double rainfall regime with a growing period of 270 days or more, excepting along the Guinea Bissau coast where the it pinches off at the southern border of Senegal, extending as far as the 180-day growing season boundary of the semi-arid tropics. This drier portion of the sub-region was added for its coastal lowland character, and the corresponding resource managment problems related to estuaries and islands, and onshore landuses that affect them.

Soils

Soils are generally of moderate to low productivity, being dominated by low activity clay soils, which are fragile or easily degradable under cultivation of annual crops. Kaolinitic(white ceramic grade clay) soils, or Ultisols, have developed on the highest rainfall coastal portion, and coarser Alfisols are found further inland.

Alfisols are more fertile than ultisols, but more susceptible to erosion.

Table.3.1. Dominant soils of the sub-region, by classification system.

	INRA (French)	FAO	USDA
Soils			
upland soils, very acidic and leached	ferralitic soils	Acrisols	Oxisols
coastal soils, acidic, coarse textured, kaolinitic	same	same	Ultisols
slightly acidic, less leached soils derived from sandstone and basement complex rocks	ferrugi-nous soils	Luvisols	Alfisols

Vegetation

Only about 10% of the original forests remain.

In general the coastal forests are drier than humid equatorial forests on other continents. Few places receive more than 2000 mm of rainfall, but atmospheric humidity along the coast is very high, including in the lower rainfall transition zone to the sub-humid tropical uplands.

On the dry peripheries of the sub-region,forests are deciduous and survive only in the deepest ravines where they have escaped fires and logging. Grass savannas occur in the zone, reflecting soils limitations to forests, e.g. drainage or hardpan, and probably the effect of burning.

Of special biological value are the coastal evergreen rainforests along the Atlantic coast from Sierra Leone to eastern Cameroon .

Species diversity is less than comparable forests on other continents,but many species are unique to the sub-region. The high degree of plant and animal endemism is partly due to its isolation from the more interior humid equatorial lowlands of Central Africa. Estimates are that up to 59% of the plants, 32% of the ungulates and diurnal primate species are confined to this sub-unit, mainly the closed canopied tropical forests (IUCN 1986).

Besides supplying valuable wood products, the unmanaged lands are major sources of animal and plant food and medicinal products (Prescott-Allen 1983). Within this subregion, game meat provides an estimated 9-15% of the average per capita animal protein intake. Among the rural poor the percentage can be double or triple this figure. Because of this traditional use and marketing of wildlife, the subregion has a great potential for commercial game ranching and controlled harvest, particularly in Ghana, Liberia and Nigeria.

Agricultural landuse

Export crops are important, namely rubber, oil palm, and cacao, grown in block plantations or by smallholders in traditional mixtures of tree and food crops, grown near compounds,often protected by walls. Food cropsd are primarily cassava, yams maize and rice. Rice is indigenous to parts of the sub-region (Sierra Leone), and is grown under a wide range of conditions using traditional methods, as well as modern

technologies. The green leaves of many indigenous, cultivated plants are used in traditional dishes. Numerous wild forest species yield fruits; 150 species were found in a survey in Nigeria.

Trypanosomiasis is endemic to the zone. Livestock are pigs or small ruminants or trypano-toleratnt Ndama cattle, mostly kept as milk cows. Herds of cattle are brought into portions of the zone during the dry season in Nigeria.

4.2 Natural resources and environmental management

The management issues of concern in these working papers are those of rural environments. However, in this sub-region,urbanization has resulted in growing demands for electricity and construction materials, including furniture grade woods that are being rapidly depleted in the remaining forests. Electricity must be generated from rivers and at sites in the contiguous sub-humid tropical uplands, however.

Forest exploitation and loss

Forests in the sub-region are being rapidly logged and cleared. Forest loss within this subregion is seven times the world average. Sierra Leone has only 18% of its original forest cover, Ivory Coast 10%. At the present rate of deforestatior, there will be complete loss of all tropical forests in Ivory Coast by the year 2000 (WRI 1986). With this, will be the loss of many of the endemic plant and animal communities.

Growing and now dense rural populations practicing shifting cultivation in the humid forested zones, have converted these to secondary succession bush in different stages of regeneration after cultivation, usually not exceeding 5 meters in heighth. Periods of cultivation are becoming longer, and of fallow, shorter(Okigbo, 1980). Over-cultivation leads to mixed grass and weeds, tolerant of impoverished soils. Grass savannas occur in the zone also, reflecting soil limitations.

The region is not exempt from firewood scarcities, despite its high rainfall. FAO found no foreseeable fuelwood supply problem only in the most humid sections of coastal Liberia, Ivory Coast, and Nigeria(FAO, 198). Elsewhere, however, a long history of settlement, present dense populations, and somewhat lower rainfall combine to create a situation of present or foreseeable fuelwood shortages.

Biological conservation

The Ivory Coast and Liberia have been identified as priority countries for forest ecosystem conservation by FAO, (1985) The

World Resources Institute and The World Bank. IUCN (1979) has also included Sierra Leone and, in addition, recommended surveys of natural forests in Guinea and Guinea Bissau where information is lacking.

The IUCN/SSC Action Plan for African Primate Conservation 1986-90 (1986) re-affirms the need for tropical forest management activities within these countries.

The Tai National Park in the Ivory Coast is by far the most important reserve of biological diversity in this Subregion according to IUCN and WRI. Other areas of concern are:

- o Sapo National Park - Liberia
- o Mt. Nimba Reserves - Liberia
- o Loffa Mano/Gola Forests - Liberia/Sierra Leone
- o Massif du Zeama - Guinea

All parks and forest reserves need assistance in their management efforts. Even Ghana, with its successful system of parks and forest reserves has severe strains on its ability to manage these areas. Ghana is also a leader in game ranching and marketing activities in West Africa.

Wetlands Management

Of major concern are the coastal wetlands of Guinea Bissau and the possible effects of agricultural developments and water management projects on its productivity and use by migratory birds. The mangrove forests and intertidal mudflats' biological productivity is increasingly threatened by ricefield developments. There is an immediate need to integrate wetlands conservation and agricultural development to maintain this coastal system.

Soils management

The soils management problems in the subregion have been reviewed at length(Greenland and Lal, 1977). They are, principally rapid decline of fertility, cation exchange capacity and pH, danger of laterization, poor drainage and compaction. Shortened fallows owing to land scarcity are leading to degradation, as elsewhere in traditional farming areas of Africa. Agroforestry solutions are gradually being developed(see below).

Burning adds to the problem. Brush fires not only destroy vegetation, they also speed the process of soil degradation in farmed areas where fallowing is still practiced. Fires set by Peul herders in Oyo State,Nigeria, southwest of Ibadan, are considered to be a major factor in the reduction of organic matter, humus and phosphorus in fallowed soils. Moreover, a hard, pebble-strewn surface had evolved after repeated burnings. Consequently, 20-year-old fallows had poorer soils than 5 and 10-year old fallows(Areola, 1980).

Soil compaction from as well as weeds are associated problems in clean tilled food crop cultivation. IITA has evolved no till cultivation techniques for maize and cassava that avert both problems, however, pesticides are required to prepare fields for cultivation. These are simply unavailable to the majority of farmers. Also no till farming does not work on all soils.

A substitute for fallowing -- alley cropping -- has been developed for food crop cultivation in this climate. Results of ten years' of research in alley cropping at IITA in Ibadan, Nigeria, are showing how leguminous trees planted in rows within fields, and seasonally pruned(pollarded) for their production of nitrogen-rich foliage can serve much the same purpose as bush gallow(Ahn, 1986), and make possible sustained production on soils that in the past had to be fallowed.

Other species are being researched also. They will be needed for site conditions not tolerated by Leucaena which does not grow well on the acidic lowland Ultisols of the sub-region.

It is apparent that for upland farming, agroforestry in support of the twin goals of soil conservation and food production, i.e. sustainable agriculture, must be the subject of a continuing, expanding and location/crop system specific research program in this sub-region.

Fisheries

Fisheries management problems in the sub-region were not discovered by this review. Coastal and offshore fisheries are not productive, compared to the fisheries off the coasts of Senegal, Cape Verde and Mauritania, to the north. Excepting the Ivory Coast, only one half the total fish catch of the nations in the sub-region comes from the ocean. Also, except for the Ivory Coast, exports are not a significant portion of the total catch.

The total marine fisheries catch for the sub-region in 1983 was 401,000 mt, over half of which came from Ghana and the Ivory Coast. By comparison, in the same year Mauritania caught 312,000 mt.Shrimp, spiny lobster and flatfish are the principal export items. In the Ivory Coast, fish and crustacean exports totalled 27,000 mt in 1980 and increased to 38,000 mt in 1983(FAO,1985), representing 1/3 of the total catch. At the same time the Ivory Coast also imports fish in volumes exceeding its own catch, although the value is less than that of the lower volume exports.

4.3 AID activities in the sub-region

The following countries in sub-region receive U.S. development assistance:

- Guinea-Bissau
- Sierra Leone
- Liberia
- Ghana
- Togo
- Benin

USAID portfolios had no current or planned activities concerned with natural resources or the environment in these nations.

However, AID supports research at the International Institute of Tropical Agriculture, in Ibadan, Nigeria, where important advances in agroforestry for the African humid tropics have been researched since 1976. The geographic and research scope of this work should be greatly expanded so as to speed the discovery and diffusion of adapted agroforestry solutions for intensified, sustainable agriculture in this environment.

AID's contribution to IITA has represented approximately 25 % of the Institute's operating budget.

S&T's Forestry Support Program, managed by the U.S. Forest Service, has funded the survey by ICRAF of agroforestry systems around the world. The survey, mainly of published material, was nearing completion in early 1986, and has been processed for computerized storage and retrieval. Systems for this sub-region are included in the survey.

4.4 Preliminary recommendations

This sub-region presents environmental homogeneity, but large differences in the state of development. Almost all nations in

the sub-region have a strong commodity export orientation, with Ivory Coast and Nigeria presenting substantial energy and industrial sectors in addition.

The development of intensified, sustainable food cropping systems is a need in all the countries of the sub-region, however, only Liberia and Sierra Leone must their food exclusively in this humid environment. Other states in the sub-region extend into the more favorable sub-humid tropical uplands.

Activities at IITA that seem worthy of consideration for AID support are:

* Survey and dynamic description of traditional agroforestry systems and species.

Field research grants could be awarded for interdisciplinary teams. Coordination with IITA and ICRAF would be imperative.

* Support for additional basic and applied research on mixed tree and food cropping systems, for all major soils of the sub-region, through IITA and national agricultural research institutes.

In addition, an appropriately scaled effort to preserve plant genetic resources and biological diversity may be considered:

* Support for the creation of herbaria in the various countries of the region, for useful trees.

* Support for field research and surveys aimed at better defining potential biological preserves.

Fairly high priority should be accorded by the nations and donors to better management and, where appropriate, preservation of remaining forests, particularly in Sierra Leon and the Ivory Coast.

Guinea Bissau's coastal estuaries, islands and mangroves should be the object of a master management planning exercise, integral to or as a follow-on to the present national conservation strategy planning work.

* * * * *

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5.0 Humid Equatorial Lowlands

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5.1 Description

This sub-region is dominated by Zaire(2,343,941 sq km). Other states are Cameroon, an important AID recipient(current program $113 million total obligations), Congo, Gabon and Equatorial Guinea. The Congo River drains most of these lowlands.

In contrast to the equatorial tropics of South America or Asia, the sub-region is drier. Rainfall in excess of 3000 mm occurs only on the coast of Cameroon(3948 mm/yr at Douala). Only a small part of the Zaire basin receives more than 2000 mm per year. Rain in excess of 100 mm per month is seldom the case. Dry periods of several days can occur, even during the rainiest months. There are two rainfall peaks, typical of equatorial latitudes. Temperatures average 25 degrees C and show little seasonal variation.

Vegetation and soils

A mixed, moist semi-evergreen forests is the most extensive type in this sub-region, being found on well drained soils except for the wettest and driest extremeties(White, 1983). It is floristically rich. Along major rivers and their deltas swamp forests flourish, with trees attaining heighths of 45 m.

This sub-region contains Africa's greatest reserve of forests. Its 140 million hectares of closed forest equal 60% of Africa's total closed forest resource. Almost one half of Zaire is covered by closed forest, representing the largest surface of contiguous, closed forest in Africa, and the third largest in the world(after Brazil and Indonesia)(Guppy, 1984). 76% of Gabon is still forested.

Table 5.1 Forests in the humid equatorial lowlands
(Source: WRI, 1986, Table 6.1)

	Forests open	Forests closed	Protected
	(million hectares)		
Zaire	72	106	5.7
Congo	0	22	0.1
Equatorial Guinea	0	1.3	?
Gabon	-	20	?
Totals	72	148	5.8

This subregion shows a very high rate of endemism (80% for plants, 36% for birds and 45% for ungulates and diurnal primates). Unlike the rest of the African continent, this subregion is not facing immediate pressure on its biolgical systems.

Soils

The most extensive soils are Oxisols(termed ferralitic soils by French soils scientists). These are well drained, deeply weathered reddish soils, some with large amounts of iron and aluminum oxides. Their intensive cultivation for food or cash crops requires constant use of costly inputs of lime, multi-element fertilizers and pesticides, each with its own problems, especially when improperly used(Okigbo, 1982).

Landuse

The sub-region's forest resources are not being exploited as rapidly as elsewhere in Africa. The pace of deforestation is slower than on the West Africa coast.An estimated 220,000 ha are of forests are lost per year in the sub-region, compared to 290,000 ha per year in the Ivory coast alone.

In 1983 Zaire's wood exports were worth $18 million. By comparison the Ivory Coast alone exported $334 million in wood.

Agriculture is largely in the form of shifting, subsistence level cultivation of cassava, yams, maize and rice. Seven million hectares are cultivated in Zaire(3% of the land). An additional 2 million hectares are cultivated in Congo,Gabon and Equatorial Guinea(WRI, 1986, Table 4.1). Landuse in Cameroon's equatorial lowlands can't be estimated since its aggregated with the rest of the nation.

A traditional farming method employed in the Congo illustrates the diversity of techniques that used by shifting agriculturalists where traditional systems dominate(97% land used thusly)(from FAO, 1980). Land preparation in one region of Oxisols involves cutting green matter, mounding it up, covering it with layers of earth and firing it. Raised beds formed thusly are planted in manioc, vegetables, tobacco. One farmer,(most being women), can work .2 to .5 hectares per year in this way. After three years the land is fallowed.

This techinique is termed ecobouage in French. Tractors or animal drawn plows present no advantage or improvement, but green manuring and small additions of calcium could help. Also, newly researched techniques of alley cropping may be applicable to these soils.

Fisheries

Freshwater fisheries are an important harvest in Zaire. FAO estimated an annual catch in 1983 of 100,000 metric tons, almost equal to the catch on Lake Chad.

5.2 Natural resources and environmental management

Unlike parts of the Western African coastal lowlands, this sub-region is neither short of land nor fuelwood resources. Unsustainable rates of land and other resource uses are not in evidence for the most part. The exception is a portion of southern Zaire, east of Kinshasa, where there exists a critical shortage of firewood(FAO, 1979).

Three major categories of resource management needs emerge from this overview:

* Development of sustainable agricultural systems, especially food production systems,

* Development of sustainable forest exploitation systems and programs.

* Development of the bases for conservation of genetic ressources and biological diversity.

The problems of rendering subsistence agriculture more productive in this sub-region are essentially the same as on the humid West African coastal lowlands. Low fertility, and quickly exhausted soils are common to both sub-regions. The difference lies in less population pressure. In fact, FAO's study of population supporting capacities in Africa projected no future problem of excess population relative to food production capacities, even at low levels of technology(FAO, 1982). Almost every other region in Africa will become over-populated by 2000, some even at intermediate and high levels of farming technology.

Thus, in the sub-region there is little cause to be concerned about a decline in the arable land resource due to population pressures. As long as the land supply permits shifting cultivation, permanent degradation is a danger only where lateritic horizons are exposed. Oxidization and hardening to rock take place if this happens.

The concern is, rather, how to improve the lot of rural peoples. A principal means is to render the present shifting agricultural systems more productive and at the same time sustainable, whether through agroforestry solutions, improved varieties of food crops, or correction of deficiencies in soil micro-nutrients. A much wider research and development agenda can be sketched out than in situations where solutions to irretrievable land degradation are urgent.

With regard to forest resources, the developmenmt of long-term management plans for this subregion and its individual nations is needed. Past development assistance has often centered on improved techniques for forest exploitation with serious adverse consequences as happened in West Africa. Several countries, particularly Zaire, are preparing to increase their forest harvests. However, there is a lack of institutional capacity to support forest management programs setting the stage for long-term degradation.
More information is needed on the sub-region's genetic resources. As pointed out in the Nature Conservancy's Ecology Forum No. 58 (1986), the most basic tool needed to identify and plan for conservation of genetic and biological diversity is a system for gathering, supplying and retaining information.

Because the moist forests of this subregion hold the nearly half of the continent's plant and animal species, systematic data collection and evaluation is needed to plan for long-term management. Priority areas are the forests of southern Cameroon, Gabon, Equatorial Guinea, Congo, the Angolan enclave of Cabinda and the Mayome Forests of Zaire.

A related management problem affecting biological and genetic diversity in this subregion is illegal harvest pressures on the wildlife resources. In Zaire and The Congo, 50-60% of the animal protein intake is from bushmeat (Prescott-Allen 1982). However, this "traditional" form of harvest is not of major concern. Illegal hunting to satisfy export markets is the greatest danger. Most countries in this subregion lack the institutional capability to deal with this growing problem. Although this subregion has extensive wetlands and swamp forests, they have not been identified as being a management priority.

5.3 Development assistance activities in the sub-region

USAID

AID's program is very limited in this sub-region. A fisheries project is being planned for the Shaba region of Zaire.There were no programs in Gabon or Equatorial Guinea.

Other nations and entities

UNDP was supporting fisheries surveys or development in Zaire and Congo.

CIDA will lead a multi-donor forestry sector review in Zaire in 1986.

Apparent constraints to assistance

Zaire, the largest nation state in the sub-region, has in recent years allowed its agricultural development services to decline. In rural areas, agricultural development is being carried out not through the government ministries but through foreign organizations, mostly PVO's.

Linguistic barriers between the English-speaking states on the West African coast, and this French-speaking sub-region are un-doubtedly slowing the networking of agricultural research, especially at IITA.

A perceived lack of urgency in dealing with the forest and biological resources management needs could thwart the undertaking of actions for laying the basis for good management.

5.4 Tentative agenda for AID

Training, research, and field surveys to inventory and describe the wildland resources and soils of this sub-region are areas in which AID could help lay the groundwork for future resource management.

AID support for a management oriented definition of biological conservation needs would be a timely contribution to the antecendent work by IUCN .

Research on agricultural systems that sustain the agricultural land base can be pursued as extensions into this sub-region of work at IITA, in Nigeria.

AID may consider funding translation of key IITA documents and research reports to the French language, to facilitate technology transfer of soil conserving or soil enhancing practices.

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6.0 Madgascar and Indian Ocean Islands

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6.1 Description

This sub-region of island states is comprised of Madagascar, the Comoro Islands, the Seychelles, and Mauritius. It is distinctive for its insular character. On islands economic development, as well as environmental management present unique problems. Islands, especially smaller ones, are much more fragile in all senses than continents.

A further criterion is Madagasacar's unique flora, described below, which evolved differently from flora on the African continent. The very serious state of environmental degradation that has been reached on Madagascar confers special status to this largest island in the sub-region.

Although Madagascar's human population is not especially high (approximately 9,000,000 people in an area of 58,700,000 ha. - about 50% as large again as California.), the country is poor and its development is being undercut by environmental degradation.

Climate

Unlike the other sub-regions, a climatic homogeneity does not pertain. Numerous climates are occur on Madagascar as a result of elevation differences and the rain-shadowing effect of the north-south mountain range of granitic and volcanic rock. The climates range from very humid coastal rainforests on the narrow northeast coast, to relatively cool, sub-humid uplands to semi-arid and arid lowlands on the southwestern tip, which includes a small area of desert. Rainfall varies accordingly,

from over 3000 mm per year to less than 400 mm per year. Cooler temperatures at higher elevations limit cultivation.

The four volcanic islands of the Comoro archipelago, between Madgascar and Africa are humid, with rainfall averaging between 1500 and 3000 mm. Little natural vegetation survives.

The Seychelles archipelago consists of over 70 islands scattered over 390,000 square kilometers on a southwesterly axis 1000 kilometers long. There are granitic, coralline and sand-cay islands in the group. Species but not formations of natural vegetation survive.

Plants and animals

Madagascar has been ranked by the World Wildlife Fund as the single highest conservation priority area in the world. The flora of east and west Madagascar are so distinct that it has been divided into two centers of endemism. Madagascar's spectacular fauna and flora is unrelated to that of the African continent, and possesses what are probably the highest levels of species endemism of any country.

93% of Madagascar's 28 lemur species, approximately 80% of its flowering plants, 95% of its reptiles and 99% of its amphibians are endemic, and this endemism extends to the generic and even familial level in many cases.

White notes in the UNESCO study of Africa's vegetation that:

"Malagasay lowland rain forest is very rich in species, and varies greatly from place to palce. One hundred individual plants growing side by side may belong to more than 50 species."

Indigenous palms, ferns and orchids are especially abundant and diverse. The moist montane forest occuring at 800 to 1300 meters is equally rich.

Owing to its unusual climate, Madagascar also has a wide diversity of ecosystems, ranging from the bizarre spiny deserts in the south to dry deciduous forests in the west to moist tropical rain forests on the eastern ascarpment, each with its own fauna and flora and each facing a wide variety of threats (WWF-US 1986).

The drier West Malagasay flora is less rich but nevertheless unique: 80% of the species and 20 % of the genera are endemic. Dry deciduous forest is typical of this side of the island, however over 80% has been converted to secondary grassland or wooded grassland, which is burnt over every year.

Comoros also has a unique assemblage of wildlife, including the only populations of wild lemurs outside Madagascar. Much of its flora is still unsurveyed for species endangerment (Synge 1986). Mauritius also supports many endemic plant (75% of its total plant taxa) and animal species including nine species of threatened birds.

Fisheries and Other Coastal Resources Values

Marine and coastal resources are key elements to the productivity of the Indian Ocean island nations of Madagascar, Comoros, Mauritius and Seychelles. Per capita fish consumption within the island nations is three to ten times that of neighboring East African mainland countries (UNEP 1982a).

Several of these island nations are heavily dependent on coastal zone tourism for foreign exchange earnings. It is the mainstay of the domestic economy of the Seychelles and the second greatest foreign exchange earner for Mauritius.

In addition, coastal resources are important to other aspects of the inhabitants' livelihood. Mangrove forests provide both food, building materials and other products. The mangrove swamps of Madagascar support very profitable prawn fisheries. Coastal reefs and beaches, in addition to their fisheries, provide important sources of building material.

6.2 Natural resource and environmental issues

Biological resources

There is tremendous concern in the conservation community,both in Masdagascar and abroad, for the continuing destruction of the unique flora and fauna of Madagascar. The 1986 Madagascar Conference on Conservation of Natural Resources for Development focussed international attention on the natural resource issues in Madagascar.

Much if not most destruction is by apparently habitual and uncontrolled burning, as well as cutting of forests for wood. Grasslands have replaced most of the forests that once covered the central highlands, or the Central Domain

Human activities have already caused the extinction of 33% of Madagascar's known primate fauna (WWF-US 1986). Of Madagascar's total land areas less than 10% remain in natural forest and this figure is decreasing daily. The eastern rain

forests are the most diverse and harbor the majority of Madagascar's endangered species. According to WWF, they should receive highest priority in management efforts.
Western deciduous forests, particularly the Ankarafantsiba reserve also have high priority.

Because of the great variety of species and ecosystems and the very limited extent of many forest formations on this mini-continent, the destruction of a few hundred hectares in Madagascar can have a much more devastating effect on species diversity than in most other parts of the world.

Conditions on the other islands are equally precarious. Very little of Mauritius remains in natural forest. The native plants and animals of Comoros are increasingly threatened by destruction of the rainforest habitat (IUCN 1986).

With the exception of the montane forests of Africa, there are no other areas where the need for combined conservation and development strategies is more readily apparent.

On the other, smaller islands, vegetation is not unique, and little remains untouched. Their coral reefs, however, constitute an important scientific and tourism resource.

The land base

Soil erosion has reached "epidemic" proportions in Madgascar. AID reports that as a result of watershed erosion, 3,000 hectares of paddy rice are lost each year in the main rice growing region, Lac Alaotra. The loss cancels out the development of new paddy areas. REDSO/East Africa reports an estimated annual loss of one million hectares of agriculturally productive land(Seyler, and others, 1986).

Occasional cyclones accentuate the erosive destruction of torrential rains in Madgascar, and compel an additional measure of durability in erosion control works.

There are only 29 million hectares under cultivation in Madagas-car(WRI, 1986, Table 4.1), or 2.9 hectares per person on average. In 14 years, the population will reach 15 million. Clearly, the island can't afford to keep losing land at the rate of 1 million hectares per year. The man:arable land ratio would fall to 1 hectare per person by 2000, at a time when population growth rates will have attained 2.93 percent annually(WRI, 1986, Table 2.1).

Degradation of Coastal Resources

Management problems vary among the island nations with the least pressures on the resource occurring on Mauritius and some of the worst being on Comoros(UNEP 1982a):

The fisheries industries are generally small scale artesanal and commercial industries. The only nation where exploitation may be exceeding production is Mauritius.

Destruction of mangrove forests is a current problem in the Seychelles and is increasingly a problem in Madagascar and Mauritius due to building and fuelwood demands out-stripping production. This could have a major impact on coastal resources such as prawn production.

Destruction of coral reefs appears to have been controlled in the sub-region. However, in Comoros large areas of fringing coral and coral flats have been destroyed and coastline erosion is occurring as a result.

Severe soil erosion on Madagascar, Comoros and in some of the Seychelles may be damaging coastal systems similar to what has happened in Kenya. However, no documented information was available linking sediment and coastal resource productivity.

6.3 AID assistance

A small mission of two full time professionals administers the USAID program in Madgascar, with assistance from the REDSO staff in Nairobi.

A counterpart currency account in the Central Bank, holds proceeds from the sale of PL 480 food shipments. $37.0 million had accumulated by 1986, and an additional $10 million per year could be added. These funds can be used to underwrite the local costs of many activities, including environmental rehabilitation projects.

A modest but well considered package of actions is proposed for the above-mentioned problems(AID, 1986 Madagascar CDSS), subsumed under the "agricultural production response" portion of AID's strategy in Madagascar:

* agroforestry training through ICRAF and IITA

* use of counterpart funds to support local or other donor

projects, e.g. Swiss projects for (1) demonstration and training in natural forest management, West Madagascar, and (2) farm agroforestry.

* a REDSO "pre-assessment" of the role of energy,forestry and natural resources in sustaining agriculture, followed by the testing of a few interventions.

* analyses of potentials for farm forestry/conservation projects, of the current training and support of extension staff dealing with forestry and soils.

* workshop to discuss forestry/natural resource research issues.

AID/M may finance a survey of soil erosion and vegetation that would be added on to a natural resources inventory, proposed for Madgascar by the World Bank, in its "Agricultural Institutions II" project.

As a follow-up to a recent conference on conservation in Madagascar, AID/Madagascar is working with the WWF to support biological inventory and mapping activities, socio-economic research, and the development of conservation/development strategies for two reserves in the southern portion of the country.

6.4 Other donors

International conservation activities have been primarily through IUCN, WWF-International and WWF-US. Their efforts have covered a broad spectrum ranging from park protection and biological inventories to training of conservative professionals and conservation education. A major program emphasis is to work within the context of an integrated regional conservation and development strategy, particularly in the southern portion of Madagascar.

IUCN helped launch the national conservation strategy exercise in Madagascar, which led to the 1986 conference on conservatiion.

6.5 Preliminary agenda

The reported gravity of soil erosion in Madagascar,and the associated habitual burning, seem to call for more vigorous

actions and initiatives. However, the small size of the AID mission in Madagascar -- and in all likelihood of other bilateral missions -- presents a management constraint.

The answer could lie in a multi-donor program to attack the various facets of the soil erosion problem and its response.

Suitably scaled scientific and tech nical actions related to coastal environments(mangroves, reefs), and unique flora and fauna can be supported also, through various vehicles:

In reviewing on-going activities, there appears to be a lack of activity in multiple-use management. Improved management of natural forests for multiple use objectives (including biological diversity) could help offset increasing pressures on parks and reserves. It is unlikely that further major expansions of protected areas will occur beyond the 1.5% of Madagascar already included. Possibilities including natural forest management in the context of watershed protection must be explored.

World Wildlife fund staff in Madagascar have identified the need for training to insure local capabilitiesd to support biological resource management, as well as for the compilation of a data bank. AID will be making a small contribution in this respect.

There appears to be interest within the government of Mauritus to develop a coastal management program. As the resource pressures appear to be less pressing than in other areas of the subregion, there is an opportunity to work towards more comprehensive management approaches to get ahead of the problem. Comoros suffers from the most severe coastal resource pressures in the subregion, and the possibility for assistance could be epxlored.

Assistance in the management of mangrove forests, including technological transfer of management schemes from Latin America and Asia, would be useful in both Madagascar and Mauritius.

Basic coastal resource inventories to form the basis of comprehensive management plans are needed. The degree that baseline information has been developed should be assessed with the possible use of the environmental profile process to synthesize existing information and identify needs.

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Annex A

International Assistance to Africa in Natural Resources and Environmental matters

Inventory of AID and other donor projects by country (July, 1986)

A. Introduction

Recent (since 1980), on-going and planned projects are surveyed. Multi-lateral and bilateral assistance was reviewed. See Annex B for additional treatment of multilateral assistance.

The inventory is presented country by country, in alphabetical order.

Projects aimed directly at renewable natural resources and their use and management are included. Related agricultural development and research projects are included where there is an explicit focus on natural resources (soils, water, agroforestry, range).

The inventory is based on a number of documents, referenced below. Coverage is good for on-going AID projects, forestry projects by all donors (lacking financial data in some cases), and UNDP projects (which encompass most FAO work). Coverage is thin or lacking for planned actions or programmes for bilateral donors, and fair for international donors. NGO (PVO) activities are described only for the Sahelian countries, and coverage is poor.

Contents of a recently released, detailed compilation of energy, forestry, and natural resources projects in the Africa Region, supported by AID have been partially incorporated as of the current version of this Annex.

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Still to be systematically reviewed and included are the contents related to natural resources and the environment in the following documents or agencies:

AID Annual Budget Submissions
AID Country Development Strategy Statements
WFP projects (many are covered)
World Bank projects
ICRAF,ILCA, ICRISAT and IITA work (partially covered)
FAO fisheries projects (in UNDP projects list)
IUCN projects (some mention)
Other OECD donors' projects

No documentation, whatsover has been obtained on World Food Programme work in soil and watershed conservation, notwithstanding requests to the WFP offices in Rome to send documentation.

There is no organized and indexed source of WFP documents in AID.

Source Documentation

UNEP. 1985. Desertification control in Africa; actions and directory of institutions Nairobi, United Nations Environment Programme, Desertification Control Programme Activity Centre. 126 p.

Reports on surveys during 1982/83 of anti-desertification work, successes and failures, pilot projects, and available information and experience on desertification control technology. Includes (in Vol. 2) a directory of institutions and their missions, staff and projects. Quite useful.

FAO. 1986. Tropical forestry action plan. Rome, Food and Agricultural Organization of the United Nations. 211 ps.

A compendium of multilateral and bilateral grant and loan assistance to the forestry sector in developing countries, compiled during 1985. Summary listing of actions by donor in each country, without indication of duration, project name or amunt of funding.

AID. 1986. Listing of AID projects in Sub-Saharan Africa. Center for Development Information and Evaluation. Development Information Division. (computer print-out)

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Arawak Consulting Corp. 1986. Energy, forestry and natural resources activities in the Africa region. Washington D.C., Bureau for Africa, AID.

UNDP. 1986. Listing of UNDP projects in Sub-Saharan Africa. New York, Documentation and Statistics Office, Bureau for Programme Policy and Evaluation, UNDP. (computer print-out)

Active UNDP projects in the following categories (used by UNDP) were reviewed: natural resources (water and minerals) agriculture, forestry and fisheries science and technology.

B. Projects Inventory

Benin

Benin (formerly Dahomey) shares the West African coast with more humid nations, but is located in a low rainfall zone, coined the "Dahomey gap". Therefor it is entirely within the sub-humid tropical uplands sub-region. It's border with Upper Volta is also at the transition to the semi-arid zone.

The northern zone suffers the pressures on grazing resources as well as brush fire dangers from migrating pastoral groups seeking range during drought years.

Anti-desertification control efforts in the north of the country have been discontinuous and lacking in long term commitment from donor countries.

In 1986 USAID was supporting:

* development of safe water supplies in the north, including work in sanitation and hygiene education ($6.7 million)

UNDP was supporting:

* agricultural soils surveys (agro-pedologie) ($1.3 million).

* preparation of a master plan for water resources ($158,000).

* national parks development ($488,000).

* artesenal fisheries ($586,000).

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* multiple purpose forest plantations ($825,000).

* watershed management and brush fire prevention in north Benin ($244,000).

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Botswana

Botswana is almost entirely within the arid and semi-arid tropics sub-region, and the southernmost portion comprising the Kalahari desert extend into the climatic subtropics. Only 5% of Botswana is cultivable, and traditional as well as commercial cattle raising is the dominant activity. Rainfall has been below normal during 1975-85.

Human and livestock populations have grown rapidly despite the drought. Cultivation is encroaching onto better grazing areas, and herding is threatening a rich wildlife population, for which several parks have been set up.

Botswana's system of rainfall, crop production and nutrition monitoring at 500 centers around the country averted malnutrition or starvation during the 1984/85 drought.

Great investments of effort and money have been directed at modernizing and commercializing traditional livestock raising in Botswana. UNEP reported that, in 1982, ..."the development of a market oriented livestock economy has placed a high value on cattle and has encouraged water prospecting and borehole drilling to enable cattle ranching to push further west into the Kalahari sandveld. Consequently, there has been extensive, in places severe, degradation of rangeland due to overstocking, overgrazing trampling, and uncontrolled fires, characterized by accelerated wind, sheet and gully erosion. The quality and quantity of forage available to stock have been reduced due to encroachment by annuals and unpalatable perennial species." (UNEP, 1985)

This situation prevailed throughout eastern Botswana, despite government efforts to arrest range degradation. In fact some efforts have apparently aggravated rather than ameliorated the situation. Meanwhile, commercial livestock development projects are being pursued in the Kalahari Desert in parallel with efforts to conserve and manage its wildlife, and map range and water resources.

Projects:

The World Bank was planning an extension of the "second livestock development project", which had already received $7.3 million of support, and in which UNEP reported that "little progress had been achieved in respect to the control features of the project", namely to protect rangelands by controlling overstocking and overgrazing.

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USAID was supporting in 1986:

* a $11.8 million 8-year rural sector grant, running to 1988, and financing the development of landuse planning capacities, rural agroforestry and forestation, horticulture, and wildlife utilization and management as a source of income. Six Peace Corps volunteers are involved.

* development of rural renewable energy ($3.3 million)

UNDP was financing:

* soil mapping assistance ($1.1 million)

* assistance to the wildlife training centre ($490,000)

* range management ($630,000)

* pasture and fodder crop seed production ($40,000)

* range restoration and fodder development ($200,000)

The U.K.'s ODA will lead a multi-donor review of the forestry sector as a follow on to the FAO Tropical Forests Action Programme.

IUCN supported research on Kalahari wildlife in 1986, and the preparation of a National Conservation Strategy.

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Burkina Faso

"Burkina Faso is encountering serious problems of desertification engendered by bush fires in the south, clearing for cultivation and cutting trees for fuelwood in the Mossi Plateau, and overgrazing in the north." (UNEP, 1985)

In 1986, AID was supporting only one project related to natural resources: a community forestation effort in the southwest (Project 686-0934) executed through AFRICARE, with collaboration from the Peace Corps. AID funding is $1.0 million.

In late 1985, the government was working with CILSS and UNSO in the preparation of a national strategy to combat desertification.

The government began a village forestation program in 1979.

Actions to date to combat desertification include:

> $14.5 million World Bank project to strengthen the forestry service, plant 1,600 ha and manage 1000 ha of natural forest, and plant 325 ha of community woodlots.
>
> Numerous village woodlot projects supported by various donors - Sweden, Switzerland, and the Netherlands - totalling $5.75 million.
>
> UNSO funded afforestation and related research in the Sampone area (formerly Project 601)
>
> USAID support ($5.9 million) for the Dinderasso Forestry School, during 1982-85.
>
> UNDP support to strengthen the hydrological and agrometeorological services ($2.1 million) (until 1988)

Other UNDP projects of note include (from 1986 UNDP sources):

> * well drilling ($613,000)
>
> * "development" of forest and wildlife resources ($1.3 million; preceded by $500,000 inventory of wildlife resources)
>
> * village forestation in Bulkiemde and Sanguie provinces ($861,000)
>
> * creation of a national soils institute ($1.6 million)

Ecological and socio-economic research near the Oursiswamp, supported by France through DGRST.

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Burundi

Burundi is located in the tropical highlands sub-region.

In 1986 USAID was supporting:

* a project to preserve the Bururi Forest (last of two remaining high altitude forests in Burundi) by establishing fuelwood plantations around its circumference in concert with plantations sponsored by other donors, and by developing new sources of firewood and construction timber for communities in the environs. (No. 693-0105, $1.1 million during 1982-86)

* peat utilization project to provide an alternative to wood fuel. (No. 695-0103, $9.0 million, 1982-87).

UNDP supported:

* strengthening of topographic mapping and cartography ($1.0 million) and hydrometeorology ($712,000) in the Institut Geographique.

* forestry training ($1.7 million).

* support to the Faculte des Sciences Appliquees ($3.9 million).

Other donors:

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Cameroon

Desertification affects the narrow, northern wedge of Cameroon, which extends north to of Lake Chad, where livestock raising dominates. UNSO helped Cameroon develop a strategy to comabat desertification in 1979, which consisted to date of research on dryland ecosystem functioning, and impacts of environmental degradation.

In the sub-humid belt, and the humid coast, Cameroon is experiencing soil erosion, deforestation, and urban expansion problems.

USAID activities

AID was supporting the following actions in 1986 related to natural resources and the environment:

* agriculture among small farmers ($600,000)

An exploratory visit by IIED scientists on behalf of AID to examine the possibility of undertaking a Phase II environmental profile in Cameroon was not fruitful.

AID has not joined the multi-donor group working on a forestry action programme for Cameroon. (see below)

Combatting desertification

Various actions were undertaken in the early 1980's to combat desertification:

* Shelterbelt plantings, with World Bank assistance, in Diamare and Mayo Danay districts, until 1987 (originally begun in 1956).

* UNEP and UNDP supported planning for integrated development of the semi-arid northern zone.

* In 1986, UNDP was supporting a $1.9 million project titled

" Measures de lutte contre la deseretification dans le nord Cameroon" (til 1987), and agrometeorological and hydrological work in northern Cameroon.

Tropical Forests Action Programme

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In Cameroon, UNDP is the lead agency for the multi-donor forestry sector review which follows on the FAO Tropical Forests Action Programme. The review should be complete in late 1986 or early 1987.

CIDA's contribution to the review is being carried out by the International Institute for Environment and Development. A year-long dialogue on forestry policy is being stimulated among governmental, non-governmental and private sector representatives.

Elsewhere UNDP was supporting:

* development of a soils service in ONAREST ($872,000).

* strengthening of the National Soil Center ($1.2 million).

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Cape Verde

Cape Verde's desertification problems are different among the 10 major islands, but degradation of vegetation and erosion are common to all the islands, relieved only by the low rate of fuelwood consumption, relative to elsewhere in Africa.

It is estimated that existing and proposed reafforestation projects will be able to satisfy the countries fuelwood needs by the year 2000.

In 1986, there were no USAID projects dealing with natural resources or the environment.

During 1978-1984, USAID supported watershed treatment of four watersheds on Sao Tiago Island. (i.e. infiltration ditches, gully plugs, and check dams) and similar work supported by UNSO.

Other donors and USAID have supported:

* Soil conservation and other watershed treatment measures on the islands of Santo Antao (Netherlands supported) and reaforestation on the island of Maio.

* Several small scale water and wind energy development projects, supported by USAID, Denmark, and the Netherlands.

In 1986, UNDP was supporting a $0.9 million project to control desertification in the San Joao Baptista valley, and was contributing $200,000 to strengthen agromateorological and hydrological services.

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Central African Republic

The CAR lies almost entirely within the Sub-humid tropical uplands sub-region.

USAID was supporting the following in 1986:

* operational activities of the Ministry of Fisheries' national inland fisheries program, as part of the $1.0 million Rural Development Project.

UNDP was supporting:

* groundwater surveys ($453,000).

* wildlife management ($1.2 million)

* agriculture extension ($2.4 million)

* development of soils survey and soils conservation service ($672,000).

* organization and development of agroclimatological and hydrological services in the Meteorological Bureau ($620,000).

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Chad

UNEP states that "wind erosion, sand encroachment and shifting sand dunes, deterioration of both grazing and crop lands, exacerbated by a general concentration of livestock in the south due to much reduced grazing in the northern part, generally typify the desertification problem in Chad." (UNEP, 1986, p.48).

Chad stands out for early work in agroforestry with Acacia albida and wild Acacia senegal (gum arabic), assisted by CARE and the Peace Corps. The civil wardisrupted this work.

USAID has a small mission in Chad, but no projects specific to natural resources and the environment.

In 1986 UNDP was supporting:

two forest species nurseries ($800,000),

wells for human and animal consumption,

a $5.7 million technical assistance preparatory effort for rural water development.

$1.9 million project to strengthen the hydrological and agrometeorological services.

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Comoros

The four islands in this archipelago lie between the north coast of Madagascar and the Mozambique coast. They are part of the Indian Ocean Islands sub-region.

There are no USAID activities in Comoros. The US Embassy manages a small ($10,000) self help development fund (as in every other African embassy).

CARE was carrying out a five year rural assistance project that includes soil conservation, agroforestry, and reforestation, with partial funding (matching grant) from USAID.

UNDP was supporting:

* water surveys and development ($1.8 million).

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Congo

Congo is entirely within the humid equatorial lowlands sub-region.

USAID activities in agricultural development support various production inputs for smallholders, but not natural resources management per se.

UNDP was supporting:

* rural fish culture ($668,000)

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Djibouti

Tiny Djibouti lies entirely within the arid and semi-arid tropical sub-region, on the Gulf of Aden.

USAID is supporting the development of marine fisheries, now in its second phase (Fisheries Development, Phase II, $3.0 million), and the development of energy conservation and new energy sources, such as solar energy (Infrastructure and Energy Initiatives, $4.0 million).

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Ethiopia

All of Ethiopia is affected by desertification or land degradation, in both cases due to overgrazing, cutting and land clearing pressures, and over-cultivation. In 1982 UNSO was helping to prepare a national plan to combat desertification.

Ethiopia spans two sub-regions: (1) the arid and semi-arid tropics sub-region, which entirely surrounds (2) the tropical highlands sub-region

Recent or current actions to combat desertification include:

Fuelwood plantings supported by the African Development Bank and the World Bank (both loans), UNDP, Denmark, Finland, Australia, and the Federal Republic of Germany, as well as numerous NGO's.

Watershed treatment supported by the World Food Programme of accumulative total of _,000 has by 198_.

Various catchment treatment projects by World Bank (Sirinka pilot catchment), Netherlands (Colina -Hormat catchment).

UNDP also was supporting:

National land use planning, executed by FAO ($4.1 million), and cartographic training ($0.9 million).

$2.6 million assistance to Phase II Soil and Water Conservation Programme.

$1.2 million to strengthen the National Soil Service.

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Gambia

Gambia's rainfall of around 800 mm places it in the southern more humid margins of the Sahelo-sudanian zone. Brush fires set by nomadic pastoralists are the principle cause of land degradation in this tiny country that borders the lower Gambia River. A different kind of degradation has resulted from the reduced flow of the Gambia River during the drought. Its estuary has become so saline and freshwater inputs so reduced that mangroves are dying as a result. Swamp rice cultivation has also been adversely affected.

USAID

USAID recently completed an environmental assessment of the impact of dams and other forms of river basin development in the Gambia River Basin. The assessment recommended against a salt barrier dam as well as a large hydropower dam upstream. AID has also sponsored range ecology and management research, undertaken by the U. of Colorado (1979-86, $9.0 million).

During 1978 to 1987, USAID is supporting institution-building and planning for soil and water conservation through a contract with the U.S. Soil Conservation Service. Activities include management support to the Ministry of Agriculture and Natural Resources. (Project No. 635-0202, $2.7 million).

Four Peace Corps volunteers in agro-forestry were posted in Gambia in 1985.

In 1982, UNSO and other donors were supporting fire prevention work. In 1986, donor support had shifted to supporting improved wood stove development and dissemination.

The FRG was assisting in the preparation of a master forestry plan.

In 1986 UNDP was supporting numerous activities related to desertification and degradation:

* construction of small dams and protection of agricultural lands from salt water intrusion ($470,000).

* rangeland management and protection of land around livestock watering points ($400,000); development of watering points for livestock ($850,000).

* strengthening the agro-meteorological and hyrdological services of the Dept. of Water Resources ($546,000).

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Ghana

Ghana's territory spans the humid coastal lowlands and the sub-humid tropical uplands.

In 1986 USAID was not supporting projects concerned with natural resources and the environment.

IBRD led a multi-donor review of the forestry sector in early 1986.

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Guinea

Guinea's northern half, approximately, lies within the sub-humid tropical uplands sub-region, while the coast is within the West African humid coastal lowlands. Drought touched northernmost portion, and herders from the Sahel migrated to Guinea during the drought, putting pressure in grazing resources and aggravating the problem of brush fires. These pressures, plus deforestation in the Fouta Djallon massif threaten the catchment areas of the Senegal, Gambia and Niger rivers, all which have their origins in Guinea.

UNSO helped Guinea in 1981 to draft a national plan to combat enviornmental degradation, which included watershed management forestation, bush-fire control, and "sensibilisation" of local people to issues of enviornmental degradation.

France will lead a multi-donor review of the forestry sector in 1986, as a follow on the the FAO Tropical Forests Action Programme.

Also, UNDP and World Bank were supporting in 1982 the development of a master plan for water resources development.

In 1986, UNDP was supporting or had recently completed:

* assistance to the national hydrological service and for watershed management in the uplands ($2.0 million).

* water resources planning ($2.0 million).

* forestry training and demonstration center ($1.2 million).

* reforestation, protection and management of the Kokoulo river basin ($1.2), and the Fetore, Koube and Tene basins ($3.4 million).

* strengthening of the national meteorological service, Phase II ($1.6 million).

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Guinea-Bissau

This former Portuguese colony lies at the drier extreme of the humid coastal lowlands. Inland it falls within the sub-humid tropical uplands sub-region.

USAID was supporting a $4.5 million rice development project, nearing completion, but no activities concerned with natural resources or the environment.

UNDP was supporting:

* integrated development of the Bijagos islands ($400,000).

* rural water works ($1.8 million).

A National Conservation Strategy was in preparation, with IUCN support, in 1986.

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Ivory Coast

AID's West African REDSO office is located in the Ivory Coast, but currently there is no AID program in this "middle income" country.

UNDP was supporting the following activities related to natural resources and the environment:

* fisheries development ($1.3 million)

* rural fish culture ($866,000)

* strengthening of the climatological and agrometeorological offices ($510,000).

The IBRD will lead a multi-donor review of the forestry sector in 1986 as a follow on to the FAO Tropical Forests Action Programme.

A National Conservation Strategy was in preparation, with support from the IUCN.

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Kenya

Expansion of cultivation into marginal (steep, arid) areas, exploitation of woody vegetation for fuel, and unmanaged stock watering points have combined with drought or erratic rainfall to cause degradation and desertification in Kenya.

Compared to other drought afflicted nations, considerable governmental and non-governmental efforts are being expended to combat degradation and desertification. There are 95 non-governmental organizations in Kenya, with a coordinating organization, KENGO. Multilateral and bilateral projects are so numerous as to present a major problem of coordination. In December, 1983, USAID surveyed over 400 projects in Kenya concerned with natural resources and the environment. Only a few are mentioned here.

UNEP and ICRAF headquarters in Kenya have served to focus attention on environmental and agroforestry issues.

USAID

During 1982-85 USAID supported centralized planning and related enviornmental profiles at the district level, as part of the government's initiative to decentralize planning. This is a structural change considered to be key to effective resource management.

Through the Energy Initiatives for Africa regional project, USAID was supporting a variety of NGO activities, coordinated by KENGO, such fuelwood lot plantings, agroforestry, and improved woodstoves development and diffusion.
Range and livestock management.

Various projects have been underway since the early 1980's aimed at easing the pressures on the range resources:

* IPAL, or Integrated Project for Arid Lands, is a UNESCO and FRG-backed long term research effort to establish the ecological and related socio-economic basis for a more rational and conservative use of range resources threatened with degradation in northern Kenya.

* Grazing blocks, initially supported by a USAID project, are being continued by the GOK, with the aim of better managing range. Cooperative ranching is also being assessed by the government as a range management alternative. World Vision Relief Organization was also attempting the establishment of a cattle ranching approach for nomadic pastoralists - the Samburu tribe.

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* Winrock International recently terminated a long involvement in the Kiboko Research Station's development of range and livestock management systems, east of Nairobi

* UNDP has furnished long term support for development of forage plants ($880,000 in 85-88).

Forestry

A forestry sector review was being undertaken by a multi-donor group lead by World Bank in 1986, as a follow on to the FAO Tropical Forests Action Programme.

Dryland forestry was being promoted in various ways:

* research and planting trials of 40 species of potential use in rehabilitation projects.

* USAID support (in 1982/83) of reforestation and erosion control in Kitui district.

Other actions:

* dryland farming research development (UNDP,$4.0 million total).

UNDP was supporting, in addition:

* management plan for the catchment of Lake Victoria ($1.47 million).

* exploration of geothermal energy (Phase II, $1.9 million).

* the Green Belt Movement ($110,000).

* coastal agriculture ($134,000).

UNEP's review of Kenya's progress in combatting desertification singled out the special success of mobilizing women's groups to participate in environmental rehabilitation efforts.

A4

Lesotho

This tiny (size of Maryland) landlocked state in the subtropical highlands of Southern Africa is perhaps more severely eroded than any comparable region in Africa outside of the Ethiopian highlands. At the same time efforts to control erosion in Lesotho have been exerted since colonial times, and continue now with international assistance, especially through the World Food Programme, as well as USAID.

Most of Lesotho's arable lands are in the lower lands, which have lost an estimated 30 centimeters of soil and where over 30,000 hectares have been destroyed by gullying (Flannery, 1979)

In 1986 USAID was supporting:

* land conservation and range development. a $12 million, 7-year project begun in 1980.

* Forestation and wildlife management within a larger rural development grant, 1980-88.

* development of renewable energy technologies based wood, sun and wind ($3.3 million).

UNDP was supporting:

* a pilot solar energy and biogas project ($680,0900)

* strengthening of the hydrological service ($696,000)

* five year post for a conservation forest officer

* animal feeds and fodder for drought relief ($270,000)
(more to come from WFP and UNEP docu ments, 6/12/86)

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Liberia

Liberia occupies the humid coastal strip of West Africa.

No AID activities were planned or underway dealing with the management of natural resources or the environment.

UNDP was supporting:

* development of natural resources administration ($1.0 million).

* management and legislation for a water resources policy ($932,000).

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Madagascar

Madagascar is the most important of the islands in the Indian Ocean islands sub-region. The reknowned uniqueness and precarious status of its edemic flora have attracted international attention. A National Conservation Strategy has been prepared and adopted (in 1984) by the government, and a conference on its implementation took place in November, 1985.

Proposed AID activities in 1986 were several:

* agroforestry training through ICRAF and IITA.

* use of counterpart funds to support local or other donor projects, e.g. Swiss projects for (1) demonstration and training in natural forest management, West Madagascar, and (2) farm agroforestry.

* a REDSO "pre-assessment" of the role of energy, forestry and natural resources in sustaining agriculture, followed by the testing of a few interventions.

* analyses of potentials for farm forestry/conservation projects, of the current training and support of extension staff dealing with forestry and soils.

* workshop to discuss forestry/natural resource research issues.

AID/W may finance a survey of soil erosion and vegetation that would be added on to a natural resources inventory, proposed for Madagascar by the World Bank, in its "Agricultural Institutions II" project.

UNDP was supporting:

* assistance to the Department of hydrography and oceanography, in the Institute National de Geodesie et de Cartographie ($460,000), and other assistance to the Institute ($811,000).

* research and development program for renewable energy ($200,000).

* marine fisheries development ($117,000).

* agriculture and freshwater fisheries development ($672,000).

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* strengthening of the infrastructure at the National Oceanographic Research Center, and marine resource development ($895,000).

Other donors:

* Switzerland will lead a multi-donor review of the forestry sector in 1986, as a follow on to the FAO Tropical Forests Action Programme.

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Malawi

Malawi lies entirely within the sub-humid tropical uplands sub-region. It shares Lake Malawi with neighboring Mozambique and Tanzania.

USAID was funding agroforestry research, as part of a $14 million agricultural research extension project (612-0215) for the period 1985-90, and still in the start-up phase.

UNDP was supporting:

* strengthening of hydrological services ($656,000).

* a national water resources master plan ($423,000).

* forestry training ($128,000).

* strengthening of the national meteorological services ($400,000).

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Mali

Over half of Mali is in the hyper-arid Sahara, into which the Niger River loops before flowing southeast into Niger. Cattle raising in this region including the Sahelian zone bordering the Sahara, relies importantly on the Niger's interior delta, which has been progressively drying up, jeapordizing the dry season floodplain pastures as well as draw down agriculture and fishing. This comes at a time of increasing competition among farmers and herders for the delta's humid soils. Many farmers and pastoralists have moved southwards, some into Bamako. Herders have concentrated in the more humid southern areas of Mali, corresponding to a portion of the Sub-humid upland Sub-region as well as the adjacent Semi-arid regions, in the latitude of Bamako.

In 1982 UNSO was assisting in the preparation of a national plan to combat desertification.

Into the early 1980's, block forest plantations were being pursued, notably in a World Bank project. By 1985, this approach had been abandoned in favor of small scale village woodlots and agroforestry approaches, supported by World Food Programme, Canada, EEC, FAO/World Bank, FRG, Italy, Netherlands, Norway, and USAID.

AID is presently supporting:

* the extension of a livestock production project totalling $14.0 million. Range management is not a specific output of the project, however.

* research on semi-arid crops -- sorghum, millet and cowpeas - which was nearing completion at the end of 1985. Cost: $4.7 million.

* a three -year farming systems research with in Mali's Institute of Rural Economy, begun in 1985. Cost: $6.6 million.

* village reforestation in the Fifth Region ($3.6 million)

* resettlement of 11,000 Malians displaced by the Manantali Dam ($18.5 million).

* a $15.5 million, 10-year forestry project was in the start-up phase (Project 608-0235, Forestry Sector Development). It is designed to strengthen the Malian Forest Service in the Fifth Region.

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UNDP in 1986 was financing:

* development planning of a zone rid of river blindness ($764,000).

* oasis development on the "salt route" ($1.4 million).

* groundwater resources development (since 1977, $16 million).

* strengthening of agrometeorological and hydrological services ($620,000).

* assistance for the production and marketting of cattle ($2.4 million); for cattle development in the western Sahel ($2.0 million), and for "support centers" for cattle development ($1.4 million).

* resettlement studies of people that will be displaced by the Manantali dam ($320,000).

* studies for development of fisheries, bee-keeping, and agricultural development on the Goubo plain.

FAO will lead a multi-donor review of the forestry sector in Mali, as a follow on to the FAO Tropical Forests Action Programme.

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Mauritania

Shifting sand dunes and their encroachment on oases and towns, overgrazing, and salination of irrigated lands in the delta of the Senegal river are the essential environmental problems of this nation, which has not been able to feed itself since 1975 and exists by virtue of international largesse.

The nation has a national plan to combat desertification.

Sweden was supporting a public education program regarding desertification in 1985.

In 1982 DANIDA was supporting the planting of a greenbelt around Nouakchott to buffer it from sand and dust; other subsequent support from Luthern World Relief.

EDF was supporting a gum arabic regeneration project in 1982.

In 1986 USAID supported:

* rural dam building and treatment of waterborne diseases ($8.9 million)

* integrated development of oases in southern Mauritania ($6.0 million).

* small scale irrigation along Senegal River ($460,000)

* agricultural research in Kaedi and related support structures (#3.8 million).

In 1986 UNDP was supporting:

* dune stabilization ($3.0 million)

* well repair ($1.0 million)and earth dam construction ($1.5 million, since 1981).

* groundwater development ($380,000) and well operation ($485,000)

* strengthening of agrometeorological and hydrological services ($1.2 million).

IUCN was assisting in the preparation of a plan to conserve endemic flora and fauna. Other non-governmental organization activity included OXFAM's support of fuel efficient stoves.

UNEP makes special mention of the role of local religious leaders in the conservation of forest reserves, and the significance of local customary authorities in this regard. Also noted is the surprising recovery of local flora and animal species in the green belt area around Nouakchott, due to its protection from grazing (UNEP, 1985, p. 66).

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Mozambique

Except for its arid southern coastal plain, Mozambique lies within the sub-humid tropical uplands sub-region.

Currently, USAID has no program in this country, although there is an American Embassy .

In 1986 UNDP was supporting:

* establishment of a water resources institute ($2.17 million)

* natural resources survey and land evaluation ($3.0 million)

* Marine fisheries development and training ($5.0 million)

* trypanosomiasis and tse-tse fly control ($680,000)

* forestry engineering department, Faculty of Agronomy ($1.1million)

* forestry development and forest industries production ($3.0 million)

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Niger

All of Niger lies within the arid and semi-arid sub-region. Most of Niger's territory is in the Sahara desert. Niger suffers from severe desertification over much of its territory, resulting from the unrelieved cutting, grazing and browsing during the long drought. Salinization has affected areas along the Niger river as well as oases. Livestock raising and fisheries appear to be in a slow decline. The physical environment is suffering from spreading desertification; pastures are taking longer to re-establish themselves after grazing while fallow period for cultivated soils have been reduced. Nevertheless in years of adequate rainfall, i.e. 1985, Niger can feed itself and even produce a surplus.

Niger has announced a major commitment to combat desertification (engagement to Maradi). IUCN has initiated the planning process for a national conservation strategy in Niger.

USAID projects in recent years have included support for forestry agroforestry, and landuse planning, but all these activities are being terminated by Dec. 1987. The results and technologies developed will be incorporated in various other projects in the portfolio.

The Niger mission's has drafted a new development strategy that will support irrigated agriculture (for" drought-proofing"), agricultural research and support to local development groupings, and strengthening institutional capacity for policy analysis, planning and management. The mission also intends to engage contract staff working on various other projects to assist the National Forest Service to develop a national strategy for anti-desertification.

In 1986 USAID projects involving natural resources were:

* forestry and land use planning, a 7 year $2.46 million project to be terminated in 1987. Results from the Guesselbodi range management site have yielded new insights on the social and ecological aspects of range rehabilitation.

* agricultural production support project, a $14.7 million project that seeks to strengthen the Ministry of Rural Development and its various services and operations

* reforestation training in ten rural training centers, as a component of the Niamey Department Development project. The centers promote and fund multi-facetted development.

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*17 Peace Corps volunteers were assisting in agroforestry and village woodlots in 1985.

* assistance to the Niger Basin Authority to plan and identify projects for development in the river basin, being phased out early because of Niger government's inability to comply with condition precedent of staff salaries.

* integrated livestock production ($5.0 million), that was to yield a range management plan, including re-seeding and conservation. Drought has undercut the project, which is being phased out. (Verify with AID/Niger)

European and UN agencies were supporting a variety of anti-desertification and forestry efforts:

* sand dune stabilization -- Denmark through FAO, Church World Service

* agroforestry and village forestry, windbreaks -- Netherlands, Norway, Sweden, France, Catholic Relief Service, CARE.

* institutional support and strengthening to the forest service -- France, World Bank, FRG

UNDP was supporting:

* an extension of the Acacia albida regeneration project in Dosso.

* sand dune stabilization around Bilma (perhaps same as Denmark's project above) ($1.4 million)

* soils mapping ($3.1 million since 1978)

* shelterbelt plantings around Tahoua ($480,000)

* rural water supply development ($1.8 million)

* research and training for agricultural implements in the Sahelian zone ($2.0 million).

* strengthening of agrometeorological services ($775,000)

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Nigeria

Nigeria is not an AID country, however AID does support research at the International Institute of Tropical Agriculture in Ibadan, where ground-breaking research in alley cropping has been pursued over the last 6 years.

Nigeria's territory spans three sub-regions: West African humid coastal lowlands, sub-humid tropical uplands, and the semi-arid portion of the Arid and Semi-arid tropics sub-region.

Anti-desertification projects are several, aiming to establish woodlots at various scales, and shelterbelts.

Forestry projects elsewhere include:

* World Bank loans for industrial plantations

* technical and vocational training supported by Denmark and World Bank.

* UNDP technical assistance in forest management and wood utilization.

UNDP was also supporting:

* artesanal and inshore fisheries development ($2.6 million)

* range management in Sokoto ($321,000)

* development of a forest management capability ($3.0 million).

* livestock development in grazing reserves ($2.9 million)

* development of a national earth resources data base for soil conservation and landuse planning ($220,000)

* establishment of genebank facilities for conservation and utilization of horticultural germplasm ($438,000).

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Rwanda

Rwanda lies entirely in a portion of the East African Highlands sub-region. It is one of the most densely populated nations in Africa (ave 265 persons/sq km), and is especially threatened by land degradation from a combination of over-cultivation and easily eroded steep soils.

USAID is supporting:

* agroforestry activities, carried out as part of the Energy Initiatives for Africa project, centered in Nairobi.

* a regional assessment of natural resources and environmental management problems, in Ruhengeri, as a final activity under the Environmental Training and Management in Africa project (approximately $9090,000 in two phases).

* research on soil fertility maintenance, as a sub-project of the $15.8 million Farming Systems Improvement project.

* pond agriculture (Fish Culture project, $2.45 million).

* one time sampling of soil erosion rates at 100 sites, as part of the first national agricultural survey (Rwanda Agricultural Survey and Analysis project, $3.67 million).

UNDP is supporting various mineral surveys, as well as work to tap methane gas in Lake Kivu.

World Bank is funding a forestry project affecting the Gishwati National Forest.

European donors are active:

* Belgian is undertaking a 1:50,000 topographic mapping.

* France is carrying out a soils survey in the Ruhengeri Prefecture, using new 1:20,000 aerial photography.

* Switzerland is funding technical assistance in forestry and agroforestry.

* GTZ recently ended a seven year project to develop agroforestry systems in the highlands (Nyabisindu), the Project Agropastoral. It is now being evaluated and a final report is in preparation.

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Non-governmental organizations are also active.

* World Wildlife Fund supports research on gorillas in the Parc des Volcans.

* CARE is supporting village forestation and watershed forestation.

* bench terracing and related agricultural intensification is being supported on a small scale by a religious order from Belgian.

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Senegal

Like other Sahelian countries, Senegal has developed a Plan of Action to Combat Desertification. It was recently evaluated for the World Commission on Environment and Development in Geneva by the Ecole Nationale d'Economie Appliquee, of Dakar (ENEA. 1985).

Senegal's performance in achieving the goal's of the 27 recommendations of the U.N. Conference on Desertification's Action Programme was found wanting. This is consistent with worldwide findings ten years after the conference. Senegal's plan to combat desertification, which was to have been produced by a Committee set up in 1981, was based upon many unconnected sectoral approaches.

Also various other committees, a master plan for forestry development, and a major national conference on combatting desertification have lacked coherence. The recent (1984) formation of a Ministry of Nature Protection, which includes forestry and soil conservation as well as parks management is a step forward.

This level of attention was sorely needed both to deal with the gravity of natural resources degradation in Senegal and to coordinate donor support. In 1986, twenty three donors were supporting forestry projects in Senegal, totalling over $53 million in value.

In 1985, IUCN initiated the preparation of a National Conservation Strategy, and of a regional pilot project for the strategy, working with the Ministry of Nature Protection.

USAID activities in 1986 related to natural resources included:

* completed national survey of natural resources, consisting of 1:250,000 maps and accompanying monographs of landuse and vegetation, soils, groundwater, geomorphology ($2.0 million) (publication in atlas format of limited circulation)

* support to Africare for village woodlots ($400,000)

* decentralized farming system research, $8.6 million during 1981-1990.

* initiation of 5-year, $8.0 million project to support agroforestry and related and land regeneration actions.

Sixteen Peace Corps volunteers were working on village forestry and agroforestry in 1985.

PL 480 supported reforestation, dune stabilization and renewable energy development underway during the early 1980's has been terminated, and a planned second phase of an urban fuelwood plantation (Bandia forest) was cancelled following a negative recommendation from the Phase I evaluation.

Several Sahel Regional projects were being executed in part in Senegal -- support to the OMVS (the Senegal River Basin Development Authority), agricultural research for the OMVS, and a study of groundwater in the Senegal River basin and the possible impacts on it from the Manatali Dam.

In 1986 UNDP was supporting the following:

* support to the OMVS National Committee in Senegal

* dune stabilization near vegetable gardening areas ($850,000)

* forestry training ($600,000)

* inventory of forests in Casamance and Senegal Oriental, and management of state forests ($590,000)

* strengthening of agrometeorological service ($945,000).

Forestry and related activities were being supported by numerous OECD members:

* Netherlands, Finland, Sweden, and Norway supported various community forestation efforts through FAO and UNSO Trust Funds.

* FRG was financing forestation with gum arabic around well points, degraded from excessive cattle concentrations, and firebreaks of cashew trees in the Sine Saloum.

* Switzerland supported forestry training in southern Senegal (Ziguinchor).

* Canada was financing diverse forestry related activities: community forestry near Podor, forest fire prevention, sand dune stabilization, and assistance in forest inventory and management.

Range inventories and management projects were underway by France (research), FAO (monitoring and surveys), and management for sustained production (FAO, at Bakel, a former AID project).

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Sierra Leone

This small country is entirely within the West African humid coastal lowlands.

USAID had not activities underway in 1986 concerned with natural resources and the environment.

IUCN was supporting the preparation of a National Conservation Stratgegy.

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Somalia

Arid Somalia is suited mainy for livestock raising -- 45% of the territory is grazed -- except in the extreme southwest where some dryland, and in the future, irrigated farming, are exist.. UNEP reports that virtually all of the grazing land has been overstocked and overgrazed. Wood cutting has depleted woody vegetation near towns. Moving sand dunes endanger coastal towns.

USAID in 1986 was supporting:

* $11.1 million towards a multi-donor agricultural development effort of the Bay Region (where).

* rangeland development... a six-year, $19.2 million, multi-donor "central rangeland development" project, begun in 1979, whose purpose is to initiate a range management program in the central region of the country by means of training, technical assistance, water development, and other support. Range monitoring, grazing trials, surveys, and various management schemes and associated social organization were to be carried out (other donors - World Bank, IFAD and FRG).

* groundwater development aimed at developing a national water resources development program, through surveys, water exploitation, training, and institution building. 66 livestock wells are planned. (red flag -- see evaluations, reports reoutcome)

* forestation in the environs of refugee camps, executed through PVO.s ($6.0 million)

* Master plan for the development of the Juba River Valley ($5.25 million) to be completed in 1986.

Also in the north, USAID has joined with the Kuwait Fund for Arab Economic Development to develop rangelands, through reserve establishment, well drilling, fodder production, and demonstrations, and training (2-year schools set up). UNEP judges this project to be successful.

Soil and water conservation support in the northwest was begun by the World Bank in 1977 and was in its second phase, involving contour bunds, and gully erosion control in an entire watershed.

UNDP supported groundwater surveys and development, including institutional strengthening, in the 1970's. Currently, the UNDP programme in Somalia includes:

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* stengthening and intensification of coastal sand dune fixation activities ($2.6 million).

* rehabilitation and use of rural water reservoirs ($800,000).

* establishment of a national water centre ($620,000).

* fisheries development ($4.1 million).

* peri-urban fuelwood plantations planning ($109,000).

Various donors were supporting anti-desertification work in 1982/83:

* stabilization of coastal sand dunes (Denmark, Africare)

* rural and refugee camp forestation (FRG, Netherlands, Church World Service, CARE, Inter-Church Response for the Horn of Africa, Mennonite Central Committee)

Training in wildlife management was been supported by the U.K.

UNEP reports that sand dune stabilization projects have been quite successful, from the standpoint of community involvement and species used (UNEP, 1986, p. 79).

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Sudan

Sudan's enormous territory extends from the Libyan desert south through the Sahel into the Sub-humid tropical uplands of the Southern Provinces through which passes the Sudd or interior delta of the White Nile.

All forms of desertification afflict Sudan. These are being surveyed, researched and their solutions sought. Sudan was one of the first countries of the region to formulate an anti-desertification program (DECARP) in 1976, when USAID resumed its program.

USAID sponsored a survey of Sudan's natural resources problems, in 198_, conducted by Sudanese scientists at the University of Khartoum's Institute of Environmental Studies (Preassessment of natural resources issues in Sudan 1983. U. of Khartoum and Clark University.

In 1986 USAID was supporting or had recently supported:

* the development of rural renewable energy technologies ($4.6 million).

* diverse studies and research on resource assessment and desertification, through the Environmental Training and Management Project, carried out through the University. of Khartoum's Institute for Environmental Studies, with Clark University.

* numerous village forestation projects through PVO's (CARE, Church World Service.

* research on native leguminous trees, through the NRC's BOSTID.

* surveillance of Schistosomiasis in the Gezira scheme, an $8.48 million, 10-year project extending to 1991.

* re-estabishment of gum arabic plantations ($500,000, completed).

UNDP was supporting or had recently supported:

* water management research ($2.6 million)

* production of fuel briquettes and improved cooking stoves ($700,000).

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* fisheries development in the Sudd (1.0 million)

* re-stocking of the gum arabic belt ($1.5 million)

* management of grazing resources around permanent water supplies ($910,000).

* shelterbelts, northern region ($1.2 million)

* irrigation scheme rehabilitation ($400,000)

* regional drought rehabilitation strategies ($153,000)

* stengthening meteorological department ($190,000).

Other donors' support included:

* World Bank funded research on dry land farming systems in the degraded and drough afflicted western provinces, and a Western Savannah Project that sought to reconcile landuse conflicts between nomadic herders and farmers encroaching onto dry season range areas, especially through innovations in grazing and management.

* research on mesquite (Prosopis juliflora), supported by IDRC.

* grazing resources management around water holes (UNSO).

* Shelterbelt establishment to protect farmlands (Church World Service).

* Re-stocking of the gum arabic belt (Netherlands, Finland).

* village fuelwood lots (FAO for the Netherlands).

* rehabilitation of Khartoum's green belt (Finland).

Various projects in the sub-humid Southern Provinces, including the building of the north-south canal through the Sudd, have been suspended because of the civil war.

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Swaziland

This small nation is located at the northern edge of the subtropical highlands of southern Africa. It has a variety of climates controlled by elevation effects on temperatures.

In 1986 AID was supporting land conservation measures (Project 645-0068, $3.0 million), including terraces, grass strips, dams, canals and diversions.

UNDP was supporting:

* training in water resources management.

Tanzania

USAID projects in Tanzania are being phased out and the mission will be closed in 1986.

Portions of Tanzania are tropical highland, including the famed Mount Kilimanjaro, but most of the country is divided about equally between arid and semi-arid tropics (eastern Tanzania to the coast) and sub-humid tropical uplands).

USAID supported during 1980-84:

* an Operational Program Grant to Lutheran World Relief for improvement of village water supplies and related small scale irrigation, nurseries and vegetable/fruit gardens ($500,000).

* soil conservation, landuse planning and catchment development in 15 catchments ($590,000).

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Togo

This small neighbor of Ghana spans the humid coastal lowlands and the sub-humid tropical uplands.

No present or planned USAID activities deal with the natural resources or the environment.

UNDP has supported groundwater surveys and development in Togo.

In 1986 UNDP was supporting:

* water management strategy, phase I ($2.2 million).
* soil conservation and management ($136,000)
* reforestation in north Togo ($1.1 million).

A National Conservation Strategy was in preparation with IUCN support.

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Uganda

A National Conservation Strategy was in preparation in 1986, with IUCN support.

Zaire

Zaire's natural resources management problems are virtually those of the humid equatorial lowlands, described in the attached background document.

USAID has supported the preparation of a Phase II (field reconnaissance) environmental profile in Zaire, published in English French.

In 1986 USAID planned to support fisheries development in the Central Shaba region, within the context of an agricultural development project. No other activities were underway or planned by AID having to do with natural resources or environmental management.

UNDP was supporting:

* training in remote sensing ($164,000)

* planning mission for a program to assist forest and wildlife management sectors ($555,000).

* strengthening of the national fisheries office and improvement of artesanal fisheries ($1.5 million).

* fisheries development ($291,000).

Canada's CIDA will lead a multi-donor review of the forestry sector in 1986, as a follow on to the FAO Tropical Forests Action Programme.

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Zambia

Zambia lies almost entirely in the sub-humid tropical uplands sub-region.

At present AID supports no activities concerned with natural resources or the environment.

UNDP was supporting in 1986:

* wood energy consumption and resource survey ($392,000).

* pilot fish culture project ($1.48 million).

With IUCN support, a National Conservation Strategy has been prepared and published.

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Zimbabwe

The northern third of Zimbabwe lies in the sub-humid tropical uplands sub-region. To the south decreasing rainfall places the rest of Zimbabwe in the arid and semi-arid tropical sub-region, although temperatures are lower than in the Sahel.

USAID has supported:

* a broad effort to up-grade scientific and technical capabilities, of which remote sensing and meteorology were identified critical areas. (Science and Technology Cooperation grant, $750,000, '80-83).

No present or planned AID activities deal with natural resources or the environment.

Staff from Rodale's International Research Center (Emmaus, PA) visited Zimbabwe in 1985, and on the basis of work done there and earlier in Tanzania proposed to AID/Washington's PPC the compilation and editing for publication of cases of agriculture in Africa based on regenerative technologies, especially with respect to soils productivity. A small grant ($55,000) was awarded for the work.

IUCN has supported the preparation of a National Conservation Strategy, completed but not yet published.

UNDP was supporting:

* conference on implementation of a national conservation strategy in Zimbabwe (in 1985) ($40,000).

* medium size dams in Matabeleland ($340,000).

* strengthening of forestry training ($775,000).

* technical assistance in remote sensing applications for landuse, inventory and rural disaster monitoring ($350,000)

* rehabilitation of meteorological services ($1.7 million)

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Annex B

Background Survey of Activities Being Carried out by Multilateral Institutions concerning natural resources management in Africa

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Introduction

Projects, programs and initiatives underway among various inter-national, multilateral organizations are reviewed here. Only summary reporting is presented. More detailed examination will be appropriate in phases of the planning process when issues, still being profiled and potential actions, not yet determined, are compared to on-going work among multilaterals, bilaterals, PVO's and, of course, AID.

A few general statements on the findings are appropriate.

Important work in progress by the agencies surveyed will make significant contributions to our understanding of natural resource and their management in Africa:

* Surveys of groundwater supplies(EDF financed) in West Africa.

* Survey of present vegetative cover in Africa -- thisfirst continent-wide survey(FAO with French technical inputs)has been commissioned by FAO in the process of preparing a report, for presentation in September on agriculture, forestry, and fisheries in Africa.

* Analysis and development of policy instrements supportive of natural resources rehabilitation, management and sustainable development (World Bank).

* Digitized mapping (GIS) using 1 km cells of land degradation hazards in Africa. (FAO and UNEP are supporting this work, which is in progress and being perfected after initial problems.)

* Country studies, at the 1:1,000,000 scale, of Kenya,Ethiopia and Mozambique of population supporting capacities, as a follow-on to the completed continent-wide 1:25,000,000 map of population supporting capacities in Africa(FAO and UNDP).

These various international efforts are of direct importance to planned and future AID initiatives in Africa.For example, World Bank, FAO, and IUCN initiatives to undertake country-wide planning studies of natural resources and the environment bear directly on AID interest in undertaking Phase II Environmental Profiles(as well as agricultural sector assessments and analyses of agricultural policies).

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In general, work on forestry is greater and better reported, and more clearly evident, than is work on water resources managment or on soils, wildlife and genetic resources.

FAO

This review of FAO's work in Africa touches on some but not all of the organization's programs. In particular, work at the individual country level on soil mapping and soil conservation has not been completely surveyed yet. Most actual soil conservation and watershed treatment work has been carried out through the World Food Programme during the past ten years. Reviews of WFP forestry and soil are reported but haven't been seen yet.

Reviews of present vegetation and the land resource base

These reviews are being prepared for a "Report on Agriculture, Forestry, and Fisheries Strategy for AFrica". It is to be presented by FAO in September, 1986, in Brazzaville, at the biennial African regional con?ference. The coordinator of the report is Mr. Norse.

A map of present vegetation, has been contracted by FAO to a French group(SCET?). It will be based on satellite imagery and other sources. Copies of existing mapping material are being sent to S&T/FENR by Mr. J.P. Lanly, director of FAO's Forest Resources Division. According to Mr. Lanly, Environment Canada is also assisting with summarization and computerization for map display of the information.

Also, a review of soil conservation and the land resource base in general was commissioned for the above report. It is being prepared by a consultant, Martin Brunt.

Tropical Forestry Action Plan. FAO. 1985. (Committee on Forest Development in the Tropics). 159 p.

The Committee represents 45 countries; it had FAO set up ad hoc groups to develop action proposals for five priority areas:

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1. forestry in land use
2. forest-based industrial development,
3. fuelwood and energy
4. conservation of tropical forest ecosystems
5. institutions

WRI investment profiles, from WRI's "Tropical Forests: a Call for Action" are included in the report's Annex, under slightly different headings than those noted above, but accepted by FAO as corresponding to "four specific fields related to the
priority areas selected by the Committee", namely:

1. rehabilitation of upland watersheds and semi-arid lowlands, corresponding to "1. forestry in land use".

2. forest management for industrial uses,corresponding to " forest-based industrial development".

3. fuelwood and agroforestry, corresponding to " fuelwood and energy".

4. conservation of forest ecosystems, corresponding to "conservation of tropical forest ecosystems".

There is, however, little congruence between WRI's investment plan and the FAO Committee recommendations.

Of special note is FAO's classification of "ecological and socio-economic situations" for priority #1 Forestry in Land Use:

(1) Densely populated highlands
(2) Densely populated flood plains, coastal areas and islands
(3) Arid and semi-arid lands
(4) Lowland humid tropical forests with high population pressure
(5) Lowland humid tropical forests with low population pressure.

The report lacks a map that depicts these divisions geographically, however, they are easily identified.

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Follow-up action to the FAO Plan is taking the form of multi-donor forestry sector reviews, which in Africa will be carried out in the following countries:

1986:	1987:
Cameroon	Botswana
Ghana	Ivory Coast
Guinea	Madagascar
Kenya	Burkina Faso
Mali	Ethiopia
Tanzania	Niger
Zaire	Somalia

Three case studies of potential population supporting capacities

Kenya, Ethiopia and Mozambique are the subjects of national studies of potential population supporting capacities. The work is an extension and further elaboration of the methodology used worldwide, developed for UNFPA by FAO and the International Institute for Applied Systems Analysis.

In addition to the crop potential factors used in the earlier more general agro-eological analysis, the country studies take into account rainfall variability, tse-tse infested areas, present and projected cash crop areas and present and projected irrigated surfaces.

An improved model of the Universal Soil Loss Equation, using 7 slope classes, is also being employed. Soil erosion hazards will be analyzed in terms of erosivity(or susceptibilty to erosion) and their ability to sustain erosion losses(sensivitity).Map scale is 1:1,000,000. A computerized geographic information system will be used for spatial comparisons of statistical data and resource information(landuse, land capability, rainfall variability) related to crop potentials.

The Kenya study, being done by FAO, was to be presented in draft to Kenyan planners in mid-1986. The studies of Ethopia and Mozambique should be completed in 1988, under UNDP auspices.

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World Food Programme

This programme has directly supported soil conservation, forestation and combination of both for achieving watershed conservation and run-off control. It has undoubtedly been the single most important conservation programme in Africa if one uses the criterion of number of hectares affected.

Technical documentation available in AID of World Food Programme work in soil conservation and watershed managment is very poor. There are no technical summaries in the Food for Peace office , AID/Washington.

A review of WFP forestry work worldwide as of 1984 is avaiable in S&T/FENR(Dan Deeley),however. It was carried out through the Forestry Support Program, and entailed examination of individual project documents, a cable to missions and a memo to Food for Peace Officers requesting comments on the working document.

In 1982 AID's PL 480 contribution to WFP was financing $36 million worth of tree planting work, compared to $6 million in AID bilateral projects. However, Africa's generally weak institutional capability resulted in a lower percentage of WFP money spent on actual tree planting compared to Asia or Latin America(17% versus 33% and 25%, respectively).

IUFRO workshop on forestry research in the SSZ

Forestry research needs in the Sahelian/N. Sudanian Zone or SSZ(200 to 800 mm and at least 6 dry months) were set at a January, 1986 workshop held in Nairobi. Results will be presented to donor nations.

Botswana, Burundi and Guinea Bissau participated along with the nations of the geogaphically contiguous SSZ.

35 reearch proposals were presented, discussed, and prioritized. African and donor participants agreed on prioritizing:

* natural regeneration in silvopastoral systems
* genetic improvement of multi-purpose trees
* agroforestry research, especially concerning
    - browse species
    - the tree/agriculture interface
    - windbreaks
    - fuelwood
    - food from woody plants

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Country participants strongly supported training, extension and data dissemination networks.

Workshop proceedings are forthcoming.

Source: Feb. 27, 1986 memo from Ian G. Morison, S&T/FENR to J.D. Sullivan, S&T/FENR, Trip report on the IUFRO sponsored "Research and Planning Workshop for Africa: Sahelian and North Sudanian Zone(SSZ)".

United Nations Sahelian Office(UNSO)

UNSO was set up in 1973 to help the cou ntries of the Western Sahel dedal with the drought. In 1982, UNSO was expanded to assist all the countries in the Sudano-Sahelian region. Presently UNSO works with 22 countries:

Benin	Mali
Burkina Faso	Mauritania
Cameroon	Niger
Cape Verde	Nigeria
Chad	Senegal
Djibouti	Somalia
Ethiopia	Sudan
Gambia	Togo
Ghana	Uganda
Guinea	United Rep. of Tanzania
Guina-Bissau	
Kenya	

The semi-arid tropical countries of southern Africa are not included.

UNSO's Strategy for Survival(UNSO, New York, no date)is a brochure type document that does not contain an explicit strategy statement but instead lists "multidimensional strategies aimed at (1) recovery from the drought and alleviation of the effects of future ones, (2) arresting and where possible, reversing the process of desertification, (3) attacking the root causes and not only the consequences of drought and desertification."

In 1983, UNSO commissioned Prof. Leonard Berry of Clark University to undertake an Assessment of Desertification in the Sudano-Sahelian Region; 1978-1984(Berry, L. 1984. Clark U. andUNSO, 146 p.).

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GEMS

UNEP's Global Environmental Monitoring Programme has not yet succeeded in monitoring land use and vegetation changes in Africa. Small scale maps based on high resolution radiometer sensing from NOAA weather satellites during the past five years have not yielded accurate data on vegetative cover changes, especially forest cover. The maps produced to date(in a colorful brochure type publication) are not accurate.

UNEP's Desertification Control Programme Activity Centre

A recently distributed two volume report, "Desertification Control in Africa: Actions and Directory of Institutions"(1985, UNEP. 126 p.) gives the results of a special project begun in 1982 for "promotion of exchange of information and expertise on desertification matters". The UN Sahelian Office collaborated in this survey of all the nations in Africa with problems of desertification.

Volume I is a survey of available information and experience on desertification control activities and technology during the period 1978-1983. Bilateral as well as multilateral projects are briefly described for each country. Non-governmental organizations were not surveyed.

Volume II is a directory of institutions by country in the Sudano-Sahelian region and in Eastern and Southern Africa. The latter include Botswana, Lesotho, Madagascar, United Republic of Tanzania, Zimbabwe, and Zambia.

Vol. II appears to be an especially valuable compendium, containing details on institutional programs, activities, staff(including names) and capabilities.

World Bank

The Bank has had no over-all natural resources strategy, butthere were significant changes and initiatives taking place in April, 1986, especially for Sub-Saharan Africa. In the Operational Staff Division, a new office dealing with environmental and natural resources surveys has recently been set up. The same division is undertaking a series of analyses and country natural resource assessments focussing on the economics of natural resources management and conservation. The Bank is also proposing to assist all of Africa to up-grade hydrological and meteorological data collection. These and other initiatives are described next.

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Desertification response

Jean Gorse's(et al) 1985 diagnosis and recommendations on desertification in West Africa are "being incorporated in Bank projects in the region"(pers. comm. w/ D. Pickering, senior agricultural advisor), and in June, 1986, a workshop was held in Oslo, Norway, to present and discuss the finding with Africans.

In the West African SSZ the Bank is abandoning forestry projects per se(i.e. plantations) in favor of a more integrated,

"multi-sectoral, participatory, site-specific approach to the better management of natural resources"

An example is a project in early stages of planning in Burkina Faso, which focuses on "management of village lands" (Amenagement des terroirs).

The economic benefits and costs of environmental externalities are gaining validity in Bank analyses. In the Ivory Coast, a management plan to be developed for the Parc National de la Komoe will be justified entirely on the benefits from externalities related to the park.

Reference: "Desertification in the Sahelian and Sudanian Zones of West Africa". World Bank, 1985. 60 p. Personal communicatior with Jean Gorse, Senior Forestry Advisor, West Africa, April, 1986.

Accelerated action programme concerning deforestation in Africa

In 1985, and accelerated action programme for 1987-89, with four areas of activity was set forth:

agrofroestry and fuelwood
watershed rehabilitation
desertification
protection of ecosystems

The programme used the results of the above-mentioned FAO Committee on Forest Development in the Tropics in addition to past Bank forestry and energy studies.

The background document contains a listing African states according to the type of forest resource problem experienced, however, no reference is given for source materials. An appended list of staff papers is presumably the source.

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Economics of Natural Resources Management

A worldwide exercise is underway in the Bank to elaborate modified costs:benefit analysis and policy instruments supportive of or at least neutral to(as opposed to prejudicial to) mangement and conservation of natural resources. The effort is centered in the office of Jeremy Warford, Economic Advisor, in Projects Policy Department.

Certain analyses have already been undertaken(e.g. Sfeir Younis' review on the economics of land conservation:)and others
will be initiated shortly(names of consultants in parens):

* natural resources degradation (N. Myers).

* policy incentives(subsidies, etc.)which are environmentally damaging and the effect of a "netural" policy stance.(R. Repetto)

* practical ways to carry out "pro-environmental" policy interventions(D. Julius).

* services currently available from the Bank's Natural Resources Information Unit(J. Weber, H . Hogg, NASA)

* review of Bank experience in agricultural development in terms of the handling of environmental externalities and long term trade-offs.(D. Barnes)

Individual countries are being selected for national level "resource/environment studies" somewhat similar to AID's phase II environmental profiles, with an additional objective of identifying "investment projects" aimed at reversing environmental degradation.In Africa a preliminary selection of four countries has been made: Sudan, Somalia, Ethiopia and Kenya.

Sources: R. Goodland, World Bank and J. Warford, World Bank, personal communications.

New office dealing with natural resource and environment surveys

A few months ago this office, as yet un-named, was set up by the Vice President in charge of the Operational Staff Division. The office will combine cartographic and remote sensing capabilities in the bank, hitherto located in separate offices. It is planned to have this office carry out the

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country level studies of natural resources and the environment, mentioned above. Analyses of the possible scope and functions of the office were underway in late April.

Source: Roland Wood, IBRD. Tel. 477 6827. 4/23 telcom.

Natural Resources Mapping Index of "Ochocercaiasis" Nations.

Existing coverage of various kinds of natural resource surveys is being reviewed and the coverage(not the actual mapped information) will be shown on index maps. Mapped information being reviewed includes: geology, soils, land capability, landuse, forests range, disease vector habitats/distribution and population.

Source. J. McKenna, World Bank.

Proposal to up-grade hydrological and meteorological forecasting.

The World Bank is preparing a proposal to render more accurate and timely existing forecasting services by utilizing NOAA's very high resolution radiometer satellites, up-grading ground stations and improving extension services.

Yet to be reviewed are:

European Development Fund

West African groundwater study.

Funded by the European Economic Community(EEC) through the European Development Fund(EDF), this study will be portrayed on a 1:1,500,000 scale map. It is being conducted by French firms through the CIEH(Comite Inter-Africaine d'Etudes Hydrauliques) in Bobo Dioulasso, Burkina Faso.

IFAD

A Special Programme for Sub-Saharan African Countries Affected by Drought and Desertification has been set up, designed to help small farmers in the region overcome the effects of prolonged drought and desertification(Development Forum Vol. 16:2, March, 1986). $300 million is being raised for this effort.

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The Special Programme, which was approved by U.S. delegates at the U N Special Session on Africa in June, 1986, has five parts:

1. Rehabilitation of the traditional agricultural sector, especially in production of food staples.

2. Foster research and extension of food crops.

3. Small scale water development and control projects.

4. Agroforestry and environmental conservation.

5. Policy and institutional assistance in support of small farmers.

A three-year, $300,000 million effort is targetted.

Since IFAD's beginning in 1978, however, there has not been a special emphasis in Africa on countering the effects of desertification, even though an increasing share of IFAD's resources went to Africa by 1985(52% of its total loan commitments). In 1984, IFAD's new projects in Africa were ,with the exception of Gambia, located in lowland humid tropical nations(e.g. Liberia, Zaire, Sierra Leone) or tropical highlands(e.g.Rwanda, Malawi). Only 11 new projects were approved for Africa in 1984, due to reduced funding. In 1985 the total was .

IUCN's Sahel Rehabilitation Initiative

In June, 1986, IUCN distributed its strategy for environmental rehabilitation in the Sahel(The IUCN Sahel Report)It was prepared during February, 1985 - May, 1986, and represents a major new initiative into the rehabilitation of degraded areas.

IUCN proposes a broad strategy, within which it outlines actions it will undertake. These emphasize village level assistance conceived as a network of ecodevelopment projects, to be implemented by NGO's and other partner organizations. IUCN proposes to provide services in identifying and designing ecodevelopment projects; providing technical support for them; obtaining funds; monitoring and reporting; and strengthening local and NGO capabilities to carry out environmental rehabilitation projects. National and international level actions of a coordinating and advocacy nature are also planned.

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According to IUCN's Conservation for Development Centre, several "bridging" grants have been obtained in order to prepare actions that would eventually be funded by different donors or sources.

(1)NORAD grant to initiate additional national conservation strategies in the drought affected regions.

(2)CIDA grant to prepare an NGO network for ecodevelopment projects. Two workshops will be held in August, in East and West Africa to discuss with "qualified" NGO's a number of topics: an information service, and early warning system, and a permanent registry of projects.

National Conservation Strategies in Africa

These high level planning exercises aim to implement the World Conservation Strategy goals at the nation state level.

NCS's have been completed in Madagascar, Zambia and Zimbabwe.

NCS's were underway in:

Botswana
Guinea-Bissau
Ivory Coast
Senegal
Sierra Leone
Togo
Uganda
Zaire

In addition, pilot projects in sustainable development are being carried out in Senegal, Mali and Niger. These project are designed to integrate conservation and development goals.

Species preservation and ecosystem conservation have been important goals of IUCN's work in Africa, and continue to be. Efforts cover a wide range: scientific research, conferences, data banks of species, guidelines, legal, and educational work. Collaboration with FAO, UNEP and other donors is commonplace.

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International Conferences

Three international conferences dealing directly or partly with African problems of natural resources, desertification, etc. are mentioned next. The U N Special Session on Africa outcome is not summarized here, but the treatment was consistent to that of the conferences treated below.

African Environmental Conference.

Held in December, 1985, in Cairo, with attendance of African Environment Ministers and other governmental officials from 41 African states, the conference resolved, among other actions, to set up 150 model, self-reliant villages in 50 African states. A $55 million fund will be set up to underwrite the cost during the next five years.

Every two years the ministers will meet anew.

Four priority areas were identified: deserts and arid lands, river and lake basins, forests and woodlands, and seas.

A programme was adopted to mobilize scientific and technical resources in Africa to bring about sustainable development:

* establish eight African networks of scientific and technical institutions;

* set up national pilot projects of 150 villages and 30 pilot areas for rangeland and pasture development.

* establish mechanism for consolidating on-going sub-regional cooperative ventures, particularly those concerned with sustainable development and environemntally sound management of deserts and woodlands.

Bonn Economic Summit

In September, 1985, the second meeting of the Group of Experts on Aid to Africa took place,during the Bonn Economic Summit. Their "Report by the Group of Experts on Aid to Africa appointed by the Bonn Economic Summit"(Sept. 9, 1985 draft) deals among other matters with the environmental problems in Africa.

"...environmental degradation and food shortages must be checked and reversedd."(Preface).

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"..the destruction of the ecosystem by persistent drought and evnironmental degradation" is singled out as a main cause to Africa's crisis.

Assistance in raising food production must emphasize the "formulation and implementation of agriculture and food policies which woudl give priority to smallholder farmers, partgiculary women, who produce the vast majority of su bsistence food crops."

It calls for research on "measures, including reforestation, to prevent further envirnmental degradation."

One section is devoted to desertification. An extensive list of recommendations was set forth. A verbatim listing follows:

"In view of the complexity and gravity of the desertification process, it is proposed that the Summit Countries(W. Germany, France, Canada, Italy, Japan, U.K. and USA) and the European Community should:

support and help to coordinate closely, the efforts made to redress the problem at the initiative of the affected African countries;

incorporate into all development programmes and projects, where possible, components to safeguard and improve the natural resource base;

support socio-economic research and establish the best answers to questions such as land tenure, how to mobilize rural communities activities related to combat desertification; and how to avoid disincentives created by prolonged food aid.

support action to mobilize local communities and to allow them to tackle effectively at their level the problems of environmental protection , including in particular by reafforestation.

encourage and support the revision of formal education curricula so that they better reflect the seriousness of the environmental problem, as part of African countries' own efforts to make educatin more relevant to life in their societies.

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support the establishment of national networks between governmental, non-governmental and private agencies to exchange information on factors for combating desertification, act as clearing houses, and stimulate faster and wider action, adapted to the varied needs of different regions and commu nities.

support regional initiatives aimed at understanding the factors affecting desert encroachment and spreading knowledge of successful approaches to slowing it. This should include support for disciplined, coordinated efforts in particular from institutions like the intertropical network for research on resistance against drought and from regional associations such as the Comite inter-Etat de la Lutte contre la Secheresse dans le Sahel(CILSS), the SADCC and the East Africa Djibouti group, among others as well as support for other activities in the field;

support activities undertaken by relevant multilateral oragnizations such as the UNEP and FAO to assist national and regional activities to combat desertification."
(end quote)

IGADD - Intergovernmental Group on Drought and Development

This newly formed coordinating group recently met in Addis Ababa, Ethiopia to outline an agenda of actions, presented as summary project ideas(US Dept. of State cable Addis 03840):

Desertification:

natural resources evaluations
reafforestation
regional training center for arid lands management (Kenya)
strengthen Institute of Rangelands Rehabilitation
stengthen member countries' planning abilities
coordination of training and research
landuse research, evaluation, and extension activities

Water resources:

training in small scale irrigation
development of small scale irrigation
water harvesting
water resource mapping

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Agricultural research:

- socio-economic studies of pastoralists
- livestock improvement
- rangeland management
- camel research
- crop improvement
- fisheries research
- agroforestry research

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